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FISH DIET ANALYSIS MCLEOD AND SMOKY RIVER DRAINAGES

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1.0 Introduction

1.1 BACKGROUND

Recent monitoring by Alberta Environment (AENV) revealed selenium concentrations above water quality guidelines for the protection of freshwater aquatic life at sites downstream of three surface coalmines in the upper McLeod, Gregg and Smoky rivers, in west-central Alberta (Casey and Siwik 2000). These are the Cardinal River Coals Ltd. (CRC), Gregg River and Smoky River mines. The diet data contained in this report are based on stomach samples from fish collected by Alberta Sustainable Resource Development (ASRD) to support aquatic studies in the vicinity of these mines.

Stantec Consulting Ltd. (Stantec) was contracted by AENV to perform two separate contracts. The first contract involved identifying the stomach contents and compiling this data into an electronic database. The second (current) contract involved the integration of the diet data and fish metrics (length, with, age) into one database, and presentation and analysis of any major patterns in the database.

1.2 OBJECTIVES

The primary objective of the study was to provide a summary of the diet data and any major patterns in the diet of fish from waterbodies within the study area. The analysis included the three diet content methods used (frequency of occurrence, percent composition by count, and percent composition by weight; see Section 2.1 for details) and presentation of temporal (years and where appropriate months) and spatial patterns for the fish species among the river systems.

The scope of the data analysis was focused on using tabular and graphical data rather than statistical analyses. The study design did not lend itself to most univariate or bivariate statistical analyses for several reasons. Fish collections were done opportunistically with varying sampling methods in each year (e.g., inconsistency in the number of fish sampled for each species and sites sampled among years), and differences in the methods used to sample stomachs (i.e., stomachs were either excised and dissected or pumped out). This often resulted in small sample sizes that reduced the power and validity of potential statistical analyses. Another confounding factor was the variability in habitat between reference and exposure streams and thus the potential diet available at each site. Many of the reference sites were small, headwater streams in comparison to the exposure sites, which were typically downstream and sometimes larger. Habitat differences between these sites would have undoubtedly affected the abundance and availability of certain fish food items in one area compared to the other (e.g., more terrestrial invertebrates may have been available to fish at reference sites due to an enclosed canopy).

More specific objectives (which overlap the main objective above) were posed below as questions. However, it was recognized that these objectives would be difficult to determine given the shortcomings of the overall database, noted above.

1. What is the diet composition of different fish species?
2. How does the diet vary by time of day, season and/or year?
3. What are the differences/variability in the diet among size categories for each fish species?
4. Are there differences for same fish species among river systems?
5. What are the differences/similarities in the diet among fish species?

Generally, the study design for the project was not robust enough to determine diel, seasonal/monthly and yearly differences (using directly comparable samples/data) as outlined above. Where diel sampling was done in a stream, it was conducted during different seasons/months so that it was not possible to confidently say whether any differences were a result of diel changes in feeding patterns or a result of seasonal differences. Additionally, monthly (seasonal) sampling wasn't done in many streams and where it was done, sampling in the exposure and reference area streams was done in different months.

1.3 STUDY SITES AND SAMPLING METHODS

Fish were collected by ASRD personnel from several waterbodies in the eastern slopes of the Rocky Mountains, in the Hinton and Grand Cache areas. Fish were collected from following lakes and streams within the McLeod and Pembina River drainages, which is part of the Athabasca River basin and the Smoky River drainage, which is part of the Peace River basin. Reference streams (denoted by REF in the text, tables and figures) are defined as streams, which have had no mining development within their basin. The sampling sites were located in the headwaters of these streams. Exposure streams (denoted by EXP) were located in areas that have had mining activity in the watershed. Sampling sites in these waterbodies tended to be located in the middle or lower reaches of the stream.

McLeod and Pembina River Drainages

Reference Waterbodies (REF)

- Fairfax Lake (Pembina River drainage);
- Cold Creek (tributary of Maskuta Creek which flows into the Athabasca River);
- Whitehorse Creek (tributary to the McLeod River);
- Upper McLeod River (upstream of Luscar Creek);
- Mackenzie Creek (tributary to McLeod River);
- Deerlick Creek (tributary to McLeod River); and
- Wampus Creek (tributary to McLeod River).

Exposure Waterbodies (EXP)

- Lac des Roches (end pit lake);
- Cheviot Creek (tributary to McLeod River), downstream of waste rock dumps at an old mine site;
- Luscar Creek (tributary to McLeod River), downstream of Cardinal River Coals Ltd. (CRC) mine;
- Middle McLeod River, downstream of Luscar Creek; and
- Gregg River (tributary to McLeod River), downstream of the CRC mine and/or in the vicinity of the Gregg River mine.

Smoky River Drainage

Reference Waterbody (REF)

- Muskeg River.

Exposure Waterbodies (EXP)

- Sheep Creek (tributary of Smoky River), within Smoky River Coals mine;
- Beaverdam Creek (tributary of Kakwa River), downstream of Smoky River Coals mine; and
- Smoky River, downstream of Smoky River Coals plant site.

Fish were also collected from two lakes, Fairfax Lake (a background or reference lake) in the Pembina River drainage and Lac des Roches in the Luscar Creek drainage, both part of the McLeod River drainage. Lac des Roches is an end pit lake with elevated selenium concentrations from the Cardinal River Coal mine (Casey and Siwik 2000). Industrial activity has occurred in portions of each of these watersheds with the development of coal mining leases. For the purpose of this study, sites that are located downstream or within coal mining leases are referred to as exposure sites. These classifications are based on surface water quality data that show selenium concentrations are elevated above background levels at these sites (e.g., Casey and Siwik 2000). Five species of fish were collected during these surveys, rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), mountain whitefish (*Prosopium williamsoni*), bull trout (*Salvelinus confluentus*), and Arctic grayling (*Thymallus arcticus*). Rainbow trout was the only species targeted for collection in 1999.

2.0 Methods

2.1 STOMACH CONTENT IDENTIFICATION

Fish stomachs were collected in 1999, 2000 and 2001 and the contents analyzed by Stantec in 2002. The major objective of this work was to identify and quantify the diet components of fish. For this study, the results of the 2002 analysis were compiled and summarized in a digital format database provided by AENV. Additionally, new site and fish data provided by AENV and ASRD were incorporated into the database. Most of the time allocated in the contract was dedicated to completing these tasks

The waterbodies where fish were collected, the type of site (i.e., reference or exposure) and the years in which collections were made are summarized in Table 1. All fish collections, fish ageing and field data entries were done by ASRD and supplied to Stantec in electronic format. It should be noted that age data was not collected in all years and at all sites.

The following related methods were used to analyze the diet of each fish:

1. Frequency of occurrence of diet components

   Presence and absence of different diet components including invertebrate taxa in each sample was recorded to generate a cumulative list of taxa and major diet components in all samples. The major diet components were:

   - Aquatic invertebrates
   - Terrestrial invertebrates
   - Fish
   - Organic detritus
   - Inorganic material
   - Unidentified material.

2. Percent composition based on counts of organisms in each invertebrate taxa

   Using the cumulative list of diet components, percent composition was determined based on counts of individuals for each taxon (including fish if present) in each sample.

3. Percent composition by dry weight

   Dry weight of major diet components was measured for each sample.

In the laboratory, the preserved stomach was removed from the sample jar and thoroughly washed. Any extraneous tissue was removed from the intestine and the intestine opened

Table 1. **Sample size for water bodies within the study area, 1999-2001.**

WATERBODY	SITE	DATE SAMPLED	RNTR	BRTR	BLTR	MNWH	ARGR
McLeod River Drainage							
Fairfax Lake	Reference	May 18, 1999	3				
		December. 20, 2000	11	8			
Lac des Roches	Exposure	May 26&28, 1999	19				
Cold Creek	Reference	June 7, 2000		8			
		July 6, 2001		10			
		August 2, 2001		10			
		September 7, 2001		10			
Whitehorse Creek	Reference	May 19, 1999	10				
		October 23, 2000	4				
Upper McLeod River	Reference	May 21, 1999	10				
		Sept. 26, 2000	12	6		14	
		July 13, 2001	2	9	1	2	
		September 11, 2001	6	5	3	10	
Mackenzie Creek	Reference	October 18, 2000	7			12	
Deerlick Creek	Reference	June 7-9, 2000	16	1			
		July 10, 2001	10				
		August 3, 2001	10		1		
		September 6, 2001	10		1		
Wampus Creek	Reference	May 29, 1999	16				
Cheviot Creek	Exposure	October 5, 2000		12			

(continued)

Table 1. concluded.

WATERBODY	SITE	DATE SAMPLED	RNTR	BRTR	BLTR	MNWH	ARGR
McLeod River Drainage							
Luscar Creek	Exposure	May 17&26, 1999	10				
		June 6&8, 2000	15				
		October 2, 2000				14	
		October 14&21, 2000		5			
		July 5, 2001	2	10	8	6	
		August 1, 2001	7	10	7	8	
		September 5, 2001	5	10	10	9	
Middle McLeod River	Exposure	May 21, 1999	5				
		September 25, 2000	10			12	
Gregg River	Exposure	May 20, 1999	10				
		October, 4&6, 2000	9	12			
		July 9, 2001	16	5	1	8	
		September 10, 2001	11	10	10	10	
Smoky River Drainage							
Muskeg River	Reference	October 26, 2000	12	1	12		
Sheep Creek	Exposure	October 25, 2000			11		
Beaverdam Creek	Exposure	October 24, 2000			12		
Smoky River	Exposure	September 27, 2000	3		6	12	5

RNTR	Rainbow trout
BRTR	Brook Trout
MNWH	Mountain whitefish
BLTR	Bull trout
ARGR	Arctic grayling

using a sharp pointed scissors. The contents were washed into a sieve (sieve pore size $\leq$ 0.210 mm), thoroughly rinsed and placed in a petri dish. The contents were examined under x10 magnification and the material sorted into the following major diet components:

- invertebrate taxa (i.e., individuals and parts of organisms that are identifiable as specific taxa);
- invertebrate tissue and parts of invertebrates that cannot be identified as a taxon;
- fish;
- plant material (e.g., algae, leaf particles and caddis fly cases made of plant material);
- unidentifiable animal and plant organic material; and
- inorganic material (clay, silt, sand and caddis fly cases made of inorganic material).

Intact and partially intact (fractured or decomposed) aquatic invertebrates were identified to the lowest taxonomic level possible (e.g., species, genus, family). Terrestrial organisms were identified to family or order level. All individuals in each invertebrate taxon identified were enumerated. When parts of invertebrates were used to identify a taxon, a record was made of what part(s) were used to make the identification. Caddis fly larvae from cases were counted and the case was included in the appropriate subgroup of organic detritus or inorganic material. Fish found in the sample were identified, preserved and stored with an appropriate label.

Invertebrate and plant tissues were separated. The number and type of caddis fly cases made of organic or inorganic material were recorded. Where necessary, a subgroup comprised of undetermined plant and animal tissue was developed.

Inorganic material (e.g., clay, silt and sand), excluding caddis fly cases of inorganic material, was removed from the sample. The number and type of caddis fly cases made of inorganic material was recorded. Inorganic material including inorganic caddis fly cases was retained for dry weight measurement.

For each sample, the dry weight of the following major diet components was measured:

- invertebrate individuals, tissue and parts of invertebrates together;
- organic detritus (plant material including caddis cases made of organic material and unidentifiable invertebrate tissues);
- inorganic material (clay, silt, sand, and caddis fly cases made of inorganic material); and
- unidentifiable animal and plant detritus.

Dry weight was determined by placing each diet component sub-sample into pre-weighed foil boats. Each sample was dried in a drying oven at 105°C until a constant weight was obtained. Each sample was weighed to an accuracy level of ±0.01 μg.

Invertebrates were identified to the lowest practical taxonomic levels using the following references, as appropriate:

- Ephemeroptera - Edmunds et al. (1976) and Provonsha (1990)
- Trichoptera - Wiggins (1977)
- Plecoptera - Baumann et al. (1977) and Stewart and Stark (1988)
- Diptera (Chironomidae) - Bode (1983), Epler (1987, 1992), Grodhaus (1987a, 1987b), Jackson (1977), Oliver and Roussel (1983), Oliver et al. (1990), Roback (1985), Walker et al. (1992), and Wiederholm (1983, 1986)
- Other Diptera - McAlpine et al. (1981)
- General References - Brooks and Kelton (1967), Clifford (1991), Edmondson (1959), Klemm (1985), Merritt and Cummins (1984), Pennak (1989), Thorp and Covich (1991), and Usinger (1956).

Number, percent composition by number, percent composition by volume, and dry weight (± 0.01 μg) for the following diet components was determined for each stomach sample:

- Aquatic invertebrates
- Terrestrial invertebrates
- Fish/amphibians/mammals
- Organic detritus
- Inorganic material
- Unidentified detritus.

Stomach content data was entered into Microsoft Excel™ database and submitted to AENV.

2.2 DATA ANALYSIS

In conjunction with the stomach content data, additional information was supplied by AENV and ASRD in electronic format including the site locations, type of site (reference or exposure), sample date, time of collection (only in 2001), fish species and sample code, length, weight, sex/maturity (in 2 of 3 years), and diet composition.

The two datasets were combined into one by Stantec before further analysis was done. Data was summarized and mean values determined by species and waterbody for each diet component and taxonomic group. Fish stomachs that were empty were not used in the calculation of the means.

Data were tabulated into the following categories:

- Invertebrate composition by taxa and abundance
- Volume (%) of food items

- Dry weight (mg) and % composition of food items
- Length, weight and age of fish.

Due to the numerous invertebrate taxa that formed the diet of fish, not all taxa are presented on data summary tables. The criteria used to determine which taxa were included in the invertebrate composition and abundance tables were the number of taxa that formed a cumulative total of >80% of the total composition and abundance or the top six taxa that were found in fish stomachs from a given waterbody or season.

Mean abundance, volume, dry weight and fish metrics (length, weight and age) were calculated for each sampling site using metrics from individual fish.

3.0 Results and Discussion

3.1 RAINBOW TROUT

3.1.1 McLeod and Pembina River Drainages

3.1.1.1 Lakes

No comparisons could be made in fish diet of rainbow trout from Fairfax Lake (Pembina River Basin) and Lac des Roches since the stomachs from all fish from Lac des Roches were empty. Rainbow trout from Fairfax Lake fed primarily on chironomids and cladocerans (Table 2). It appears that there is a seasonal shift in diet in rainbow trout in Fairfax Lake. In May 1999, chironomids (mainly *Tanytarsus* sp.) formed 86.1% of the invertebrate diet while in December 2000, the planktonic cladocerans accounted for 94.9% of the total aquatic invertebrates consumed by rainbow trout from Fairfax Lake (Table 2). Rainbow trout captured in December 2000 had a greater number of invertebrates (249 cf. 163) in their diet than in fish captured in May 1999 (Table 2).

A comparison of diet components in rainbow trout from Fairfax Lake from May 1999 and December 2000 indicated that by both volume and weight, the majority of the diet is comprised of aquatic invertebrates (approximately 50%) with fish (unidentified) forming a small portion of the diet in 1999 (Tables 3 and 4). Stomachs in both years had a large proportion (40%) of organic material in them, which could have included unidentifiable invertebrate tissues or parts.

Length, weight, age, sample size, and sex ratio data for rainbow trout from the sampled lakes and streams are presented in Table 5. All rainbow trout captured in Fairfax Lake (the reference site) and Lac des Roches (the exposure site) in 1999 were females whereas in Fairfax Lake in 2000, most fish were immature. Rainbow trout from Fairfax Lake in 2000 were age 0 (i.e., young-of-the-year) to 4 years with an average age of 1.5 years.

3.1.1.2 Streams

McLeod and Pembina River Drainages

The most abundant aquatic invertebrates in the diet of rainbow trout from reference and exposure streams were mayflies (*Baetis* sp., *Ephemerella sp*., *Cinygmula* sp, *Rhithrogena* sp.), stoneflies (Taeniopterygidae [*Doddsia occidentalis*s] and Nemouridae [*Podmosta sp.*]) and chironomids (Orthocladiinae [*Criciotopus* or *Orthocladius* sp, *Tvetenia* sp.]) (Table 2). Lesser amounts of trichopterans (*Parapsyche* sp.) and the stonefly *Isoperla* sp. were also part of the diet. Generally there were no consistent differences in the major aquatic invertebrate diet components between reference and exposure streams (Figure 1). However, Gregg River fish showed the most unique diet composition in that the capniid stoneflies and simulids were more

Table 2. Invertebrate composition and abundance in rainbow trout diet, 1999-2001.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (± SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (± SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod and Pembina River Drainages									
Fairfax Lake (REF)	May 1999	163.0 ± 94.9	100	0	0	Chironomidae	86.1	-	-
						Hydracarina	12.7		
	December 2000	249.0 ± 449.3	100	0	0	Cladocera	94.9	-	-
						Sphaeriidae	1.2		
Lac Des Roches (EXP)	May 1999	0	0	0	0	-	-	-	-
Whitehorse Cr. (REF)	May 1999	26.2 ± 13.2	100.0	0	0	Taeniopterygidae	33.2	-	-
						Heptageniidae	16.8		
						Baetidae	9.2		
						Chloroperlidae	8.8		
						Hydropsychidae	7.6		
						Perlodidae	6.1		
	October 2000	47.3 ± 19.4	100.0	0	0	Taeniopterygidae	38.1	-	-
						Nemouridae	18.0		
						Heptageniidae	16.9		
						Perlodidae	7.9		
						Hydropsychidae	2.1		
						Chloroperlidae	2.1		

(continued)

Table 2. continued.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (± SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (± SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod and Pembina River Drainages									
Upper McLeod R. (REF)	May 1999	10.1 ± 6.8	95.3	0.5 ± 0.5	4.7	Heptageniidae	20.8	Carabidae	40.0
						Nemouridae	14.9	Chironomidae	20.0
						Ephemerellidae	9.9	Hymenoptera	20.0
						Baetidae	8.9	Lumbricidae	20.0
						Chloroperlidae	6.9		
						Leuctridae	5.9		
	October 2000	9.8 ± 11.3	100.0	0	0	Chironomini	33.9	-	-
						Ephemeroptera	20.3		
						Heptageniidae	9.3		
						Corixidae	9.3		
						Orthocladiinae	5.5		
						Perlodidae	4.2		
	July 2001	97.0 ± 90.5	96.5	3.5 ± 4.9	3.5	Heptageniidae	66.0	Hymenoptera	28.6
						Ephemerellidae	10.8	Ephemeroptera	14.3
						Empididae	3.6	Muscomorpha	14.3
						Amelitidae	3.1	Saldidae	14.3
						Baetidae	2.6	Capniidae	14.3
						Chloroperlidae	2.6	Coleoptera	14.3
	September 2001	16.2 ± 5.7	89.8	1.8 ± 1.9	10.2	Hydropsychidae	15.5	Formicidae	36.4
						Orthocladiinae	14.4	Rhyacophilidae	27.3
						Heptageniidae	14.4	Ephemeroptera	9.1
						Baetidae	12.4	Perlodidae	9.1
						Nemouridae	8.2	Grylloblattodea	9.1
						Ephemerellidae	7.2	Coleoptera	9.1

(continued)

Table 2. continued.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (± SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (± SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod and Pembina River Drainages									
Mackenzie Cr. (REF)	October 2000	10.0 ± 7.8	44.9	12.3 ± 22.6	55.1	Baetidae	41.4	Bibionidae	32.6
						Nemouridae	20.0	Formicidae	27.9
						Heptageniidae	8.6	Hymenoptera	15.1
						Dytiscidae	5.7	Ephemeroptera	3.5
						Corixidae	4.3	Rhyacophilidae	3.5
						Perlodidae	4.3	Mycetophilidae	3.5
Deerlick Cr. (REF)	June 2000	10.8 ± 14.3	80.1	2.7 ± 3.0	19.9	Taeniopterygidae	46.2	Formicidae	23.3
						Baetidae	6.9	Carabidae	27.9
						Heptageniidae	6.9	Araneae	9.3
						Nemouridae	5.8	Lumbricidae	7.0
						Ephemerellidae	4.6	Empididae	7.0
						Perlodidae	4.6	Hymenoptera	4.7
	July 2001	40.0 ± 41.0	79.1	10.6 ± 8.5	20.9	Orthocladiinae	30.0	Aphididae	10.4
						Simulidae	17.5	Lepidoptera	8.5
						Amelitidae	14.0	Baetidae	7.5
						Heptageniidae	13.8	Hemiptera	7.5
						Tanytarsini	8.0	Empididae	6.6
						Ephemerellidae	3.8	Tipulidae	5.7
	August 2001	27.0 ± 15.5	52.4	24.5 ± 20.2	47.6	Ephemeroptera	41.5	Empididae	24.5
						Orthocladiinae	17.8	Cicadellidae	13.9
						Heptageniidae	10.7	Psillidae	9.8
						Simulidae	6.3	Formicidae	6.9
						Baetidae	5.9	Chloroperlidae	6.5
						Ephemerellidae	3.0	Muscomorpha	4.9

(continued)

Table 2. continued.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (± SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (± SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod and Pembina River Drainages									
Deerlick Cr. (REF)	September 2001	35.3 ± 27.1	46.9	39.9 ± 56.0	53.1	Baetidae	70.3	Ephemeroptera	40.1
						Ephemerellidae	6.8	Empididae	8.8
						Heptageniidae	6.5	Chironomidae	7.8
						Perlodidae	3.7	Hymenoptera	7.5
						Ameletidae	3.4	Nemouridae	5.0
						Capniidae	2.5	Formicidae	3.8
Wampus Cr. (REF)	May 1999	1.9 ± 3.9	84.4	0.3 ± 0.6	15.6	Baetidae	25.9	Lumbricidae	80.0
						Nemouridae	22.2	Cicadellidae	20.0
						Heptageniidae	18.5		
						Perlodidae	11.1		
						Ephemerellidae	11.1		
Luscar Creek (EXP)	May 1999	9.1 ± 9.9	95.8	0.4 ± 0.5	4.2	Chironomidae	33.7	Lumbricidae	50.0
						Baetidae	13.2	Carabidae	25.0
						Nemouridae	11.0	Lepidoptera	25.0
						Tipulidae	11.0		
						Perlodidae	7.7		
						Hydropsychidae	5.5		
	June 2000	5.9 ± 9.6	14.0	36.1 ± 91.7	85.0	Diamesinae	31.8	Chironomidae	70.8
						Tipulidae	11.4	Mycetophilidae	6.8
						Rhyacophilidae	11.4	Hymenoptera	4.4
						Perlidae	8.0	Muscomorpha	3.1
						Simulidae	6.8	Araneae	2.2
						Orthocladiinae	4.5	Empididae	1.3

(continued)

Table 2. **continued.**

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (± SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (± SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod and Pembina River Drainages									
Luscar Creek (EXP)	July 2001	2.0 ± 1.4	12.1	14.5 ± 16.3	87.9	Baetidae	50.0	Diplopoda	82.8
						Simulidae	25.0	Homoptera	10.3
						Chloroperlidae	25.0		
	August 2001	11.7 ± 6.8	66.7	5.8 ± 4.8	33.3	Nemouridae	19.5	Cicadellidae	34.1
						Diamesinae	19.5	Empididae	19.5
						Collembola	18.3	Sciaridae	12.2
						Orthocladiinae	7.3	Homoptera	4.9
						Capniidae	4.9	Hymenoptera	4.9
						Heptageniidae	4.9	Simulidae	4.9
	September 2001	50.4 ± 60.0	86.9	5.5 ± 9.4	13.1	Baetidae	66.7	Baetidae	52.6
						Diamesinae	7.9	Hymenoptera	10.5
						Ephemerliidae	5.8	Diptera	7.9
						Capnidae	3.6	Cicadellidae	5.3
						Perlodidae	3.6	Aphididae	5.3
Middle McLeod River (EXP)	May 1999	12.4 ± 13.4	93.9	0.8 ± 0.8	6.1	Heptageniidae	40.3	Lumbricidae	25.0
						Chloroperlidae	22.6	Chironomidae	25.0
						Baetidae	8.1	Homoptera	25.0
						Perlodidae	6.5	Hymenoptera	25.0
						Lepidostomidae	6.5		
						Corixidae	3.2		

(continued)

Table 2. **continued.**

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (± SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (± SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod and Pembina River Drainages									
Middle McLeod River (EXP)	September 2000	10.5 ± 14.1	42.0	14.5 ± 25.7	58.0	Empididae	44.8	Orthoptera	58.6
						Corixidae	25.7	Bibionidae	6.9
						Perlodidae	12.4	Formicidae	6.9
						Heptageniidae	7.6	Ephemeroptera	5.5
						Brachycentridae	4.8	Circulionidae	4.8
						Perlidae	2.9	Coleoptera	3.4
Gregg River (EXP)	May 1999	9.4 ± 5.8	93.1	0.7 ± 1.3	6.9	Nemouridae	15.4	Lumbricidae	14.3
						Heptageniidae	12.1	Arachida	14.3
						Corixidae	12.1	Homoptera	14.3
						Baetidae	11.0	Coleoptera	14.3
						Perlodidae	11.0	Hymenoptera	14.3
						Ephemerellidae	9.9	Lepidoptera	14.3
	October 2000	51.5 ± 96.2	91.6	4.7 ± 10.9	8.4	Capniidae	37.8	Empididae	64.3
						Baetidae	17.8	Formicidae	4.8
						Heptageniidae	8.9	Bibionidae	4.8
						Perlodidae	8.7	Mycetophilidae	4.8
						Ephemerellidae	7.0	Muscomorpha	4.8
						Orthocladiinae	5.7	Chironomidae	2.1
	July 2001	11.7 ± 8.7	59.8	7.8 ± 5.5	40.2	Simulidae	60.0	Simulidae	17.0
						Heptageniidae	18.6	Baetidae	12.8
						Diamesinae	2.9	Empididae	12.8
						Orthocladiinae	2.9	Cicadellidae	8.5

(continued)

Table 2. concluded.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (± SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (± SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod and Pembina River Drainages									
Gregg River (EXP)	September 2001	20.4 ± 8.4	67.7	9.7 ± 8.4	32.3	Nemouridae	21.0	Ephemeroptera	43.0
						Baetidae	18.8	Formicidae	16.8
						Perlodidae	11.2	Hymenoptera	7.5
						Heptageniidae	7.1	Diptera	6.5
						Rhyacophilidae	6.7	Perlodidae	4.7
						Ephemerellidae	6.3	Rhyacophilidae	2.8
Smoky River Drainage									
Muskeg R. (REF)	October 2000	14.0 ±22.1	94.4	0.8 ± 1.3	5.6	Ephemerellidae	49.4	Carabidae	50.0
						Baetidae	13.7	Mycetophora	10.0
						Heptageniidae	12.5	Tipulidae	10.0
						Ostracoda	6.0	Chironomidae	10.0
						Perlodidae	4.8	Diptera	10.0
Smoky River (EXP)	September 2000	2.7 ± 2.1	0.9	309.7 ± 58.3	99.1	Corixidae	62.5	Bibionidae	72.9
						Heptageniidae	12.5	Formicidae	9.4
						Hydropsychidae	12.5	Hymenoptera	7.3
						Dytiscidae	12.5	Ephemeroptera	2.9

REF Reference site
EXP Exposure site

Table 3. **Mean volume (%) (± SD) of food items in rainbow trout stomachs, 1999-2001.**

Waterbody	Sample Date	Terrestrial Invertebrates	Unidentified Fish	Aquatic Invertebrates	Organic Detritus	Inorganic Material	Unidentified Material
McLeod and Pembina River Drainages							
Fairfax Lake (REF)	May 1999	0	11.7 ± 20.2	48.0 ± 45.6	40.3 ± 42.7	0	0
	December 2000	0	0	51.8 ± 34.0	40.2 ± 34.8	0	8.0 ± 25.5
Lac Des Roches (EXP)	May 1999	0	0	0	0	0	0
Whitehorse Cr. (REF)	May 1999	0	0	99.9 ± 0.0	0.1 ± 0.0	0	0
	October 2000	3.0 ± 4.8	0	92.3 ± 11.9	4.8 ± 7.2	0	0
Upper McLeod R. (REF)	May 1999	7.5 ± 17.1	0	87.6 ± 22.8	4.2 ± 6.6	0.7 ± 2.2	0
	September 2000	39.8 ± 38.9	0.8 ± 2.9	52.3 ± 36.2	6.3 ± 15.7	0.7 ± 2.3	0
	July 2001	5.0 ± 7.1	0	91.0 ± 7.0	0.1 ± 0.1	0	0
	September 2001	14.3 ± 14.4	0	74.8 ± 23.3	10.7 ± 11.4	0.2 ± 0.4	0
Mackenzie Cr. (REF)	October 2000	27.6 ± 35.5	0	67.7 ± 41.2	4.7 ± 11.2	0	0
Deerlick Cr. (REF)	June 2000	42.2 ± 40.1	0	41.8 ± 42.2	11.3 ± 25.5	4.7 ± 18.8	0
	July 2001	31.6 ± 22.4	0	66.0 ± 22.0	2.4 ± 4.0	0	0
	August 2001	51.1 ± 16.5	0	47.9 ± 16.5	1.0 ± 1.6	0	0
	September 2001	54.7 ± 27.6	0	39.6 ± 24.8	5.7 ± 8.8	0	0
Wampus Cr. (REF)	May 1999	17.6 ± 36.2	0	52.5 ± 46.6	26.6 ± 43.4	3.2 ± 11.1	0
Luscar Creek (EXP)	May 1999	12.9 ± 22.4	0	83.4 ± 22.2	3.7 ± 9.9	0	0
	June 2000	53.2 ± 41.8	0	44.1 ± 40.1	2.8 ± 6.5	0	0
	July 2001	80.0 ± 14.1	0	20.0 ± 14.1	0	0	0
	August 2001	44.1 ± 32.4	0	52.1 ± 31.8	3.0 ± 7.5	0.7 ± 1.9	0
	September 2001	10.8 ± 13.7	0	79.0 ± 19.4	1.6 ± 2.2	1.6 ± 2.2	7.0 ± 13.0
Mid McLeod River (EXP)	May 1999	10.6 ± 15.0	0	75.4 ± 14.8	1.6 ± 3.6	12.4 ± 18.7	0
	September 2000	37.2 ± 36.3	0.4 ± 1.3	39.1 ± 31.7	23.3 ± 36.8	0	0

(continued)

Table 3. concluded.

Waterbody	Sample Date	Terrestrial Invertebrates	Unidentified Fish	Aquatic Invertebrates	Organic Detritus	Inorganic Material	Unidentified Detritus
McLeod and Pembina River Drainages							
Gregg River (EXP)	May 1999	8.8 ± 19.0	0	89.2 ± 22.1	1.8 ± 3.0	0.2 ± 0.6	0
	October 2000	17.7 ± 31.2	0	73.1 ± 29.1	9.1 ± 15.4	0	0
	July 2001	39.8 ± 26.9	0	59.8 ± 24.7	1.5 ± 3.2	0	0
	September 2001	34.6 ± 37.8	12.4 ± 13.5	50.7 ± 48.1	9.5 ± 1.3	0	0
Smoky River Drainage							
Muskeg R. (REF)	October 2000	14.0 ± 23.4	0	85.6 ± 23.1	0	0.4 ± 1.4	0
Smoky River (EXP)	September 2000	96.7 ± 0.6	0	0.7 ± 1.2	2.7 ± 0.6	0	0

REF Reference site
EXP Exposure site

Table 4. Mean dry weight (mg) and % composition (± SD) of food items in rainbow trout stomachs, 1999-2001.

Waterbody	Sample Date	Terrestrial & Aquatic Invertebrates		Unidentified Fish		Organic Detritus		Inorganic Material		Unidentified Detritus	
		Weight	%	Weight	%	Weight	%	Weight	%	Weight	%
McLeod and Pembina River Drainages											
Fairfax Lake (REF)	May 1999	137.03 ± 143.63	46.0 ± 46.8	62.40 ± 108.07	14.2 ± 24.6	89.52 ± 82.25	39.8 ± 41.4	0	0	0	0
	December 2000	126.06 ± 222.50	51.8 ± 33.4	0	0	76.95 ± 80.11	40.1 ± 33.9	0	0	16.95 ± 53.60	8.2 ± 25.8
Lac Des Roches (EXP)	May 1999	0	0	0	0	0	0	0	0	0	0
Whitehorse Creek (REF)	May 1999	114.03 ± 12.28	99.9 ± 0.0	0	0	0.07 ± 0.0	0.1 ± 0.0	0	0	0	0
	October 2000	22.75 ± 31.51	93.8 ± 11.7	0	0	10.83 ± 18.18	6.3 ± 11.7	0	0	0	0
Upper McLeod R. (REF)	May 1999	26.35 ± 31.60	88.0 ± 22.2	0	0	1.73 ± 2.86	10.7 ± 22.4	1.65 ± 5.22	1.3 ± 4.2	0	0
	September 2000	30.02 ± 34.56	91.7 ±11.1	0.01 ± 0.03	0.8 ± 2.8	2.08 ± 4.02	6.2 ± 11.1	1.92 ± 6.66	1.3 ± 4.5	0	0
	July 2001	36.60 ± 3.94	99.9 ± 0.1	0	0	0.05 ± 0.06	0.1 ± 0.1	0	0	0	0
	September 2001	41.73 ± 47.21	88.5 ± 13.7	0	0	4.31 ± 5.64	11.1 ± 14.0	0.57 ± 1.39	0.4 ± 0.1	0	0
Mackenzie Creek (REF)	October 2000	24.20 ± 28.62	94.3 ± 12.0	0	0	2.13 ± 3.65	5.7 ± 12.0	0	0	0	0
Deerlick Creek (REF)	June 2000	46.81 ± 119.17	83.8 ± 30.8	0	0	1.40 ± 2.64	11.1 ± 25.7	0.63 ± 2.54	5.1 ± 20.2	0	0
	July 2001	23.49 ± 33.85	97.1 ± 5.3	0	0	0.70 ± 0.98	2.9 ± 5.3	0	0	0	0
	August 2001	47.85 ±37.68	98.6 ± 2.4	0	0	1.07 ± 2.02	1.3 ± 2.5	0	0	0	0
	September 2001	28.48 ± 23.29	91.1 ± 14.9	0	0	2.86 ± 5.18	8.9 ± 14.9	0	0	0	0
Wampus Creek (REF)	May 1999	18.03 ± 53.34	66.1 ± 44.9	0	0	2.25 ± 3.27	27.8 ± 44.1	0.77 ± 2.53	6.1 ± 20.8	0	0
Luscar Creek (EXP)	May 1999	89.17 ± 93.33	97.0 ± 8.1	0	0	0.61 ± 1.21	3.0 ± 8.1	0	0	0	0
	June 2000	43.44 ± 60.45	97.2 ± 7.5	0	0	0.71 ± 1.48	2.8 ± 7.5	0	0	0	0
	July 2001	30.87 ± 39.85	100.0	0	0	0	0	0	0	0	0
	August 2001	35.61 ± 73.29	90.9 ± 15.4	0	0	0.40 ± 1.03	4.9 ± 12.8	0.76 ± 1.92	4.2 ± 11.1	0	0
	September 2001	48.30 ± 50.84	80.8 ± 17.9	0.09 ± 0.20	0.1 ± 0.2	4.37 ± 6.06	3.5 ± 4.8	2.16 ± 3.31	3.9 ± 5.4	5.72 ± 7.87	11.8 ± 19.9
Mid McLeod R. (EXP)	May 1999	41.92 ± 71.03	71.1 ± 32.2	0	0	0.61 ± 1.36	1.3 ± 3.0	7.37 ± 9.40	21.6 ± 31.0	0	0
	September 2000	44.68 ± 58.38	75.6 ± 38.9	0.53 ± 1.66	0.9 ± 2.7	10.11 ± 18.53	23.6 ± 37.4	0	0	0	0

(continued)

Table 4. concluded.

Waterbody	Sample Date	Terrestrial & Aquatic Invertebrates		Unidentified Fish		Organic Detritus		Inorganic Material		Unidentified Detritus	
		Weight	%	Weight	%	Weight	%	Weight	%	Weight	%
McLeod and Pembina River Drainages											
Gregg River (EXP)	May 1999	30.48 ± 23.24	97.1 ± 5.8	0	0	0.78 ± 1.34	1.7 ± 2.8	0.28 ± 0.87	1.2 ± 3.7	0	0
	October 2000	34.51 ± 32.09	88.3 ± 17.8	0	0	3.97 ± 5.05	11.7 ± 17.8	0	0	0	0
	July 2001	10.97 ± 7.59	99.9 ± 0.2	0	0	0.02 ± 0.05	0.1 ± 0.2	0	0	0	0
	September 2001	21.43 ± 22.51	83.6 ± 82.1	24.37 ± 26.59	15.4 ±	4.70 ± 5.10	1.0 ± 1.1	0	0	0	0
Smoky River Drainage											
Muskeg River (REF)	October 2000	15.02 ± 21.32	96.3 ± 12.7	0	0	0	0	5.31 ± 18.41	3.7 ± 12.7	0	0
Smoky River (EXP)	September 2000	525.13 ± 103.35	95.6 ± 1.4	0	0	23.56 ± 3.14	4.4 ± 1.4	0	0	0	0

REF Reference site
EXP Exposure site

Table 5. Mean length (mm), weight (g) and age (years) (± SD) of rainbow trout, 1999-2001.

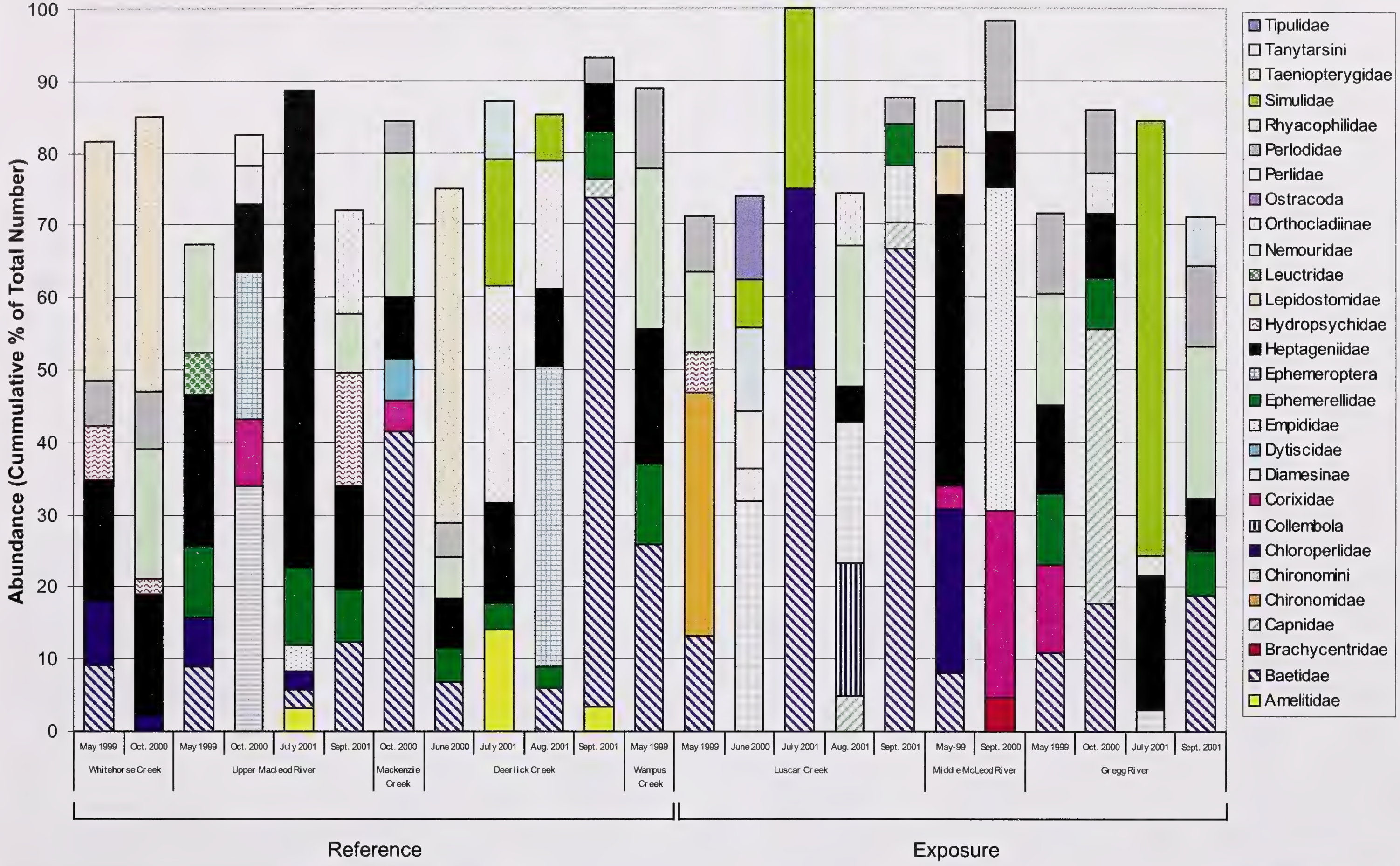
Waterbody	Sample Date	Length (mm)	Weight (g)	Age (yrs.)	N	Sex Ratio[a]
McLeod and Pembina River Drainages						
Fairfax Lake (REF)	May 1999	339.0 ± 24.9	440.0 ± 92.0	NS	3	0:3:0
	December 2000	233.6 ± 36.3	165.5 ± 71.2	1.5 ± 1.2	11	1:2:9
Lac des Roches (EXP)	May 1999	324.6 ± 66.0	412.9 ± 205.5	NS	19	0:19:0
Whitehorse Creek (REF)	May 1999	176.8 ± 13.5	63.0 ± 11.5	NS	10	5:5:0
	October 2000	229.0 ± 59.6	197.5 ± 158.7	3.8 ± 1.0	4	0:4:0
Upper McLeod River (REF)	May 1999	147.9 ± 25.7	30.5 ± 21.1	NS	10	2:8:0
	September 2000	150.2 ± 26.4	45.5 ± 33.3	2.3 ± 0.6	12	5:5:2
	July 2001	159.0 ± 0	50.5 ± 2.2	NS	2	NS
	September 2001	172.8 ± 17.6	60.7 ± 20.3	NS	6	NS
Mackenzie Creek (REF)	October 2000	149.3 ± 25.6	43.6 ± 23.6	4.0 ± 1.2	7	2:5:0
Deerlick Creek (REF)	October 2000	161.0 ± 35.2	47.6 ± 30.9	NS	16	10:6:0
	July 2001	164.2 ± 20.9	55.0 ± 16.6	NS	10	NS
	August 2001	188.8 ± 23.9	84.1 ± 21.0	NS	10	NS
	September 2001	193.1 ± 22.6	88.1 ± 30.6	NS	10	NS
Wampus Creek (REF)	May 1999	156.2 ± 12.2	33.8 ± 7.9	NS	16	0:16:0
Luscar Creek (EXP)	May 1999	199.5 ± 60.2	124.0 ± 123.4	NS	10	3:7:0
	June 2000	162.4 ± 24.5	49.5 ± 22.2	NS	15	6:7:2
	July 2001	184.5 ± 4.9	86.8 ± 1.1	NS	2	NS
	August 2001	196.3 ± 21.9	93.4 ± 23.1	NS	7	NS
	September 2001	128.0 ± 66.5	47.5 ± 57.5	NS	5	NS
Middle McLeod River (EXP)	May 1999	136.4 ± 38.9	37.5 ± 29.9	NS	5	2:2:1
	October 2000	186.4 ± 37.6	87.2 ± 48.7	2.3 ± 0.7	10	3:3:4

(continued)

Table 5. concluded.

Waterbody	Sample Date	Length (mm)	Weight (g)	Age (yrs.)	N	Sex Ratio[a]
McLeod and Pembina River Drainages						
Gregg River (EXP)	May 1999	143.1 ± 23.5	30.0 ± 22.1	NS	10	0:10:0
	October 2000	155.7 ± 35.4	51.7 ± 36.2	3.1 ± 0.9	9	1:3:7
	July 2001	172.2 ± 10.2	60.0 ± 11.6	NS	6	NS
	September 2001	162.0 ± 24.9	51.5 ± 21.3	NS	11	NS
Smoky River Drainage						
Muskeg River (REF)	October 2000	118.8 ± 33.8	19.0 ± 13.1	1.4 ± 0.5	12	2:0:9
Smoky River (EXP)	September 2000	271.7 ± 18.9	265.0 ± 57.2	4.3 ± 1.2	3	0:2:1

REF	Reference site
EXP	Exposure site
[a]	Ratio of males:females:immature
NS	Not sampled



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Client/Project

ALBERTA ENVIRONMENT

FISH DIET ANALYSIS

Figure No.

1.0

Title

Rainbow Trout Stomach Contents
Aquatic Invertebrates
McLeod River Drainage

commonly observed in the diet and in some years (October 2000 and July 2001) were the most abundant aquatic invertebrates in the diet (Table 2).

There were no major seasonal differences in diet composition of aquatic invertebrates although corixids (*Callicorixa audenia*) and dyticids (*Agabus* sp.) formed part of the diet in samples taken in the fall (Table 2). Although there was an annual shift in the proportions of these major groups they still dominated the diet of rainbow trout.

There was no clear pattern evident in terms of similarities in the composition and abundance of terrestrial invertebrates in the diet of rainbow trout from both reference and exposure area streams (Figure 2). Hymenopterans (bees, ants and wasps) were found in rainbow trout stomachs at most locations during all sampling events; however, they generally were not the most dominant terrestrial food item (Table 2). No terrestrial insects were found in the diet of trout from Whitehorse Creek during both the 1999 and 2000 sampling events.

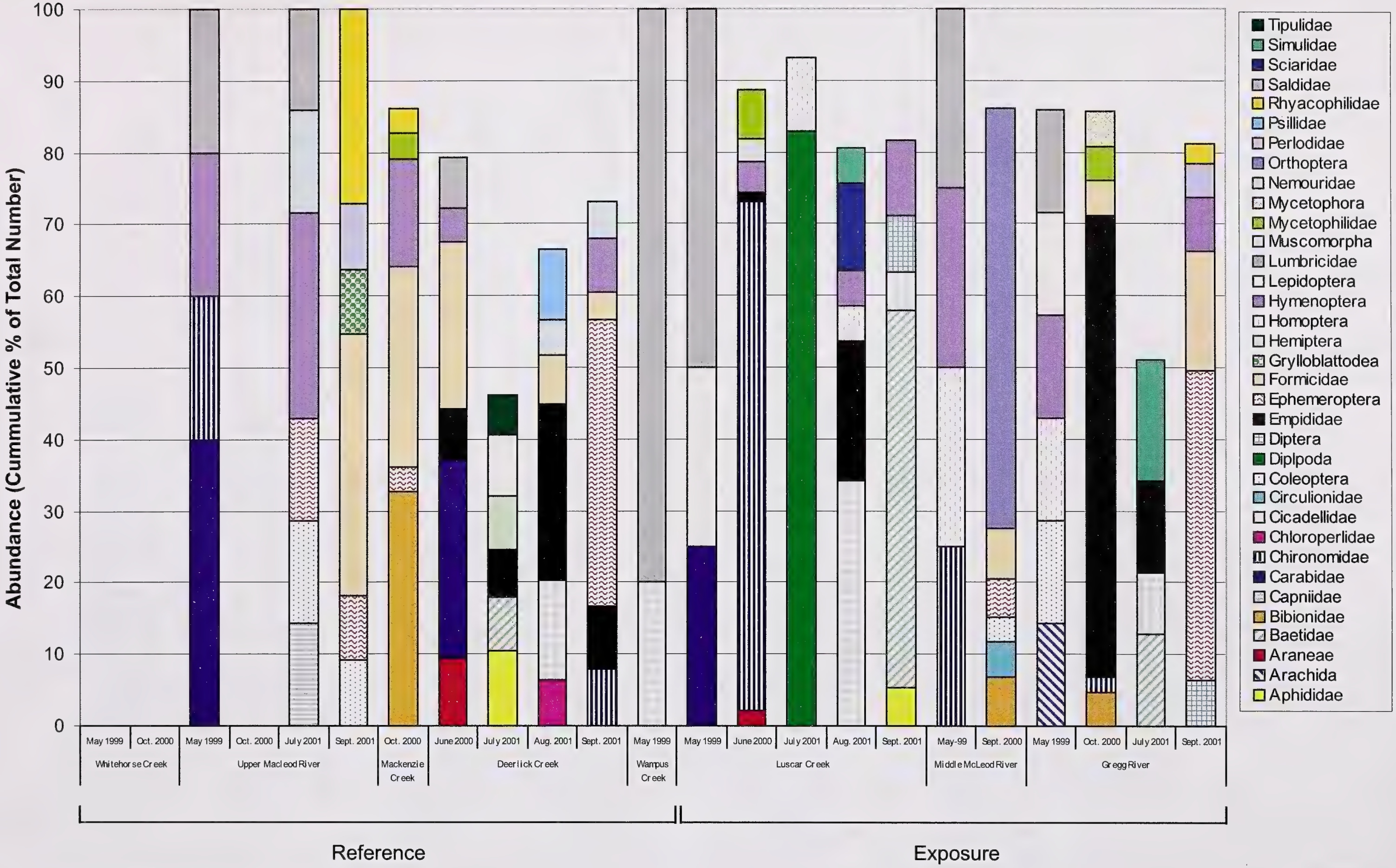
Terrestrial and aquatic invertebrates formed the bulk of the diet of rainbow trout by both volume and weight from streams within the reference and exposure areas (Tables 3 and 4). Terrestrial and aquatic invertebrates often accounted for >90% of the weight of food items found in rainbow trout diets (Table 4). Fish or fish scales, which formed part of the diet of rainbow trout from both exposure and reference streams, were found in low proportions in only a few fish.

Monthly sampling (July, August and September) was done at four sampling sites in 2001. No differences in diet components of rainbow trout were evident for Deerlick Creek and the Gregg River among the months that were sampled. However, the mean volume of terrestrial and aquatic invertebrates was lower in Luscar Creek in September 2001 compared to the other months sampled. Conversely, the mean volume of aquatic invertebrates in the upper McLeod River was higher in September than in the other months sampled.

Length, weight and age data for rainbow trout captured in streams within the McLeod River drainage are shown on Table 5. Fish from the reference sites ranged in age from 3 years to 6 years with an average age of 3.9 years. Exposure site fish ranged in age from 1 to 4 years with an average age of 2.5 years.

3.1.2 Smoky River Drainage

Mayflies (*Baetis* sp., *Drunella doddsi*, *Epeorus (Iron)* sp.) were the most abundant aquatic invertebrate found in rainbow trout stomachs from the Muskeg River reference site (Figure 3 and Table 2). Fish from the Smoky River exposure site fed primarily on corixids (*Callicorixa audeni* and *Sigara bicoloripennis*) with lesser amounts of mayflies (*Rhithrogena* sp.), caddisflies (*Arctopsyche* sp.) and dytiscid beetles (*Stictotarsus* sp.). Carabid beetles were the dominant terrestrial invertebrate in the diet of rainbow trout from the Muskeg River (Figure 3 and Table 2). March flies (Bibionidae) were the dominant terrestrial invertebrates found in rainbow trout stomachs from the Smoky River.



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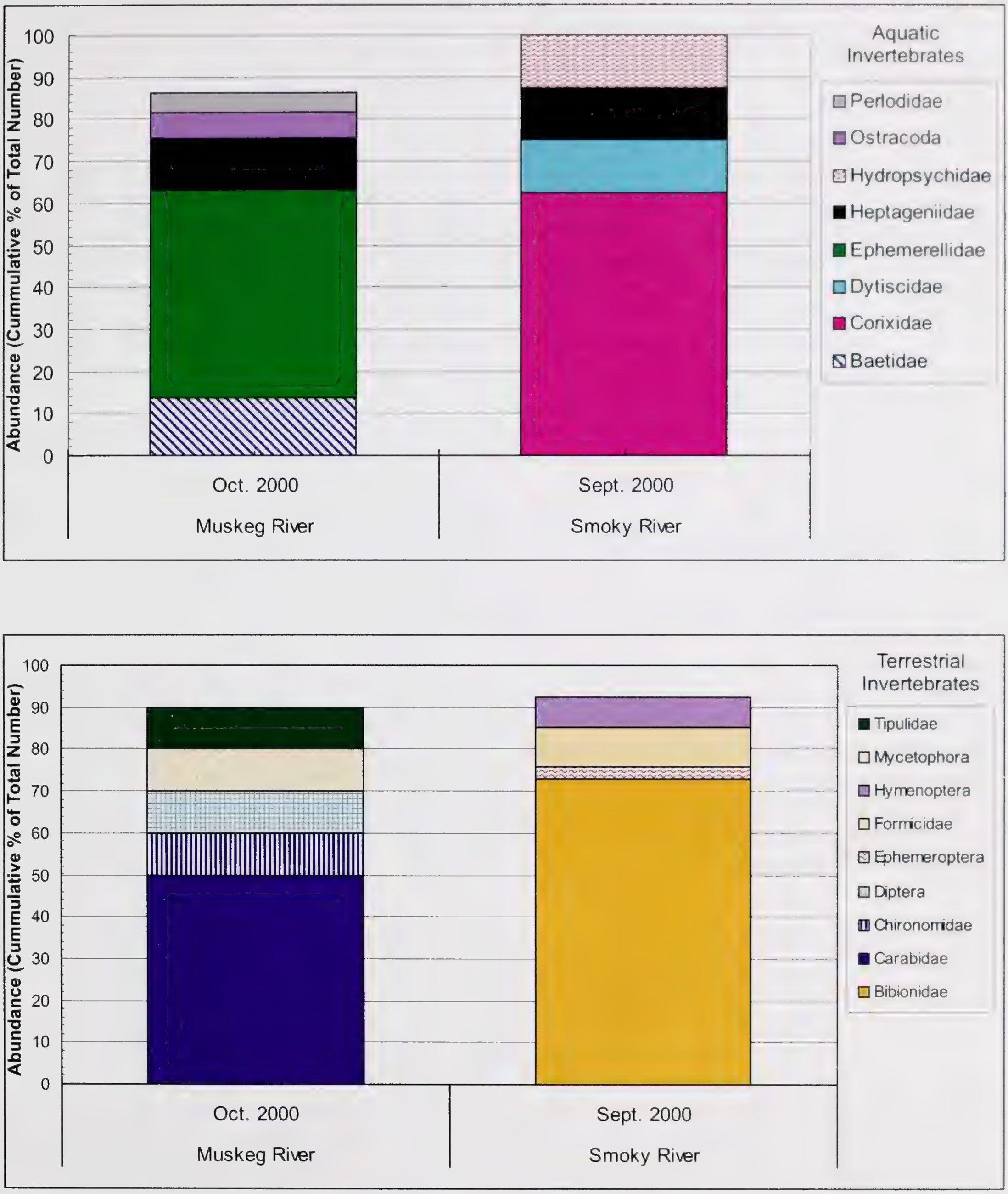
Client/Project
ALBERTA ENVIRONMENT
FISH DIET ANALYSIS

Figure No.
2.0

Title
Rainbow Trout Stomach Contents
Terrestrial Invertebrates
McLeod River Drainage



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Client/Project
ALBERTA ENVIRONMENT
FISH DIET ANALYSIS

Figure No.
3.0

Title
Rainbow Trout Stomach Contents
Smoky River Drainage

Aquatic invertebrates accounted for the majority (85%) of the total volume of food items in the stomachs of rainbow trout from the Muskeg River (Table 3). Conversely, trout from the Smoky River fed mostly on terrestrial invertebrates (97%). When comparing the dry weight of food items in trout stomachs from the Muskeg and Smoky rivers, it can be seen that invertebrates form about 95% of the diet in both streams (Table 4). However, rainbow trout from the Smoky River had a much larger mass of invertebrates than fish from the Muskeg River. Length, weight and age data indicate that fish sampled from the Smoky River were older and larger than trout from the Muskeg River (Table 5). This may account for the differences in the mass of food items in the diet. Other potential contributing factors may be related to differences in abundance of invertebrates between both streams or seasonal or diel differences related to the timing of sampling events. However, insufficient comparative data are available to conduct any further analysis of this difference.

3.2 BROOK TROUT

3.2.1 McLeod and Pembina River Drainages

3.2.1.1 Lakes

Brook trout were captured only in Fairfax Lake. The caddisfly *Phryganea cinerea* was the dominant aquatic invertebrate in the diet with lesser amounts of mayflies (Leptophlebidae and *Baetis* sp.) (Table 6). No terrestrial invertebrates were found in brook trout stomachs from Fairfax Lake. Aquatic invertebrates accounted for about 85% of the volume and dry weight of food items found in brook trout stomachs (Tables 7 and 8). Brook trout sampled from Fairfax Lake were very variable in size and age, which would account for the high variation in the number of invertebrates in the diet.

3.2.1.2 Streams

The invertebrate component of the diet of brook trout from reference and exposure streams was quite variable both monthly and between streams with no clear trend evident in food preferences between these groups of sites (Figure 4 and Table 6). Numerically, aquatic invertebrates formed a larger part of the brook trout diet than terrestrial invertebrates. Exceptions to this were in Cold Creek in August 2001 and the upper McLeod River in September 2001. Mayflies (Baetidae [*Baetis* sp.], Heptageniidae [*Cinygmula* sp]), Siphlonuridae [*Siphlonurus* sp.]), stoneflies (Taeniopterygidae [*Doddsia occidentalis*s] and Nemouridae [*Podmosta sp.*]) and chironomids (Orthocladiinae [*Criciotopus* or *Orthocladius* sp, *Tvetenia* sp.]), were the most common aquatic invertebrates in the diet of brook trout. Simulids were commonly found in the diet of brook trout from Cold Creek, Luscar Creek and the Gregg River and occasionally were the dominant aquatic invertebrate in the diet.

Similarities in the aquatic invertebrate component of the brook trout diet were not evident between years and at the same site. For example, in the upper McLeod River in September 2000, the aquatic invertebrates eaten by brook trout were primarily chironomids (Chironomini) and water boatmen (Corixidae - *Callicorixa audeni*) (Figure 4 and Table 6). In September 2001,

Table 6. Invertebrate composition and abundance in brook trout diet, 2000-2001.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (±SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (±SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod and Pembina River Drainages									
Fairfax Lake (REF)	December 2000	4.5 ± 6.0	100	0	0	Phryganeidae	58.3	-	-
						Leptophlebiidae	8.3		
						Baetidae	8.3		
						Coenagrionidae	8.3		
						Physidae	2.8		
Cold Creek (REF)	June 2000	16.8 ± 12.4	56.5	12.9 ± 10.7	43.5	Baetidae	21.6	Lepidoptera	22.2
						Heptageniidae	14.9	Formicidae	13.6
						Rhyacophilidae	14.9	Aphididae	12.6
						Simulidae	11.9	Baetidae	7.8
						Limnaphelidae	8.2	Araneae	4.9
						Ephemerellidae	4.5	Carabidae	4.9
						Tipulidae	3.7	Hymenoptera	4.9
	July 2001	19.1 ± 19.9	69.0	8.6 ± 6.4	31.0	Simulidae	29.8	Empididae	25.6
						Orthocladiinae	26.2	Formicidae	12.8
						Heptageniidae	7.9	Cicadellidae	10.5
						Nematoda	6.8	Aphididae	10.5
						Tanypodiinae	6.8	Ephemeroptera	7.0
						Baetidae	4.2	Baetidae	5.8
	August 2001	3.0 ± 2.7	18.1	13.6 ± 18.9	81.9	Baetidae	16.7	Empididae	16.2
						Heptageniidae	13.3	Ephemeroptera	11.0
						Limnaphelidae	13.3	Formicidae	10.3
						Orthocladiinae	13.3	Muscomorpha	9.6
						Nemouridae	10.0	Coleoptera	7.4
						Nematoda	6.7	Hymenoptera	7.4
	September 2001	10.9 ± 15.7	51.9	10.1 ± 14.0	48.1	Baetidae	33.0	Ephemeroptera	23.8
						Heptageniidae	18.3	Hymenoptera	12.9
						Nemouridae	13.8	Formicidae	7.9
						Perlodidae	11.0	Empididae	7.9
						Ephemerellidae	10.1	Aphididae	6.9
						Dytiscidae	2.8	Coleoptera	5.0

(continued)

Table 6. continued.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (±SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (±SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod and Pembina River Drainages									
Upper McLeod River (REF)	September 2000	7.0 ± 10.3	87.5	1.0 ± 2.4	12.5	Chironomini	59.5	Scolytidae	66.7
						Corixidae	14.3	Formicidae	16.7
						Chironomidae	7.1	Bibionidae	16.7
						Simulidae	7.1		
	July 2001	17.2 ± 12.9	74.2	6.0 ± 12.1	25.8	Ephemerellidae	18.7	Ephemeroptera	40.7
						Siphlonuridae	14.2	Carabidae	16.7
						Amelitidae	10.3	Diptera	11.1
						Tanytarsini	7.7	Baetidae	7.4
						Tipulidae	6.5	Muscomorpha	7.4
						Perlodidae	5.8	Lepidoptera	3.7
	September 2001	6.2 ± 1.9	34.4	11.8 ± 26.4	65.6	Nemouridae	25.8	Rhyacophilidae	84.7
						Perlodidae	19.4	Formicidae	8.5
						Ephemerellidae	9.7	Ephemeroptera	5.1
						Heptageniidae	6.5		
						Amelitidae	6.5		
						Orthocladiinae	6.5		
Deerlick Creek (REF)	June 2000	29	76.3	9	23.7	Taeniopterygidae	44.8	Formicidae	33.3
						Orthocladiinae	27.6	Hymenoptera	22.2
						Heptageniidae	6.9	Chironomidae	22.2
						Baetidae	6.9	Homoptera	11.1
						Ephemerellidae	3.4	Empididae	11.1
Cheviot Creek (REF)	October 2000	14.4 ± 37.8	98.9	0.2 ± 0.4	1.1	Heptageniidae	67.6	Diptera	50.0
						Baetidae	5.8	Rhyacophilidae	50.0
						Nemouridae	3.5		
						Diamesinae	3.5		
						Perlodidae	1.7		
						Amelitidae	1.2		

(continued)

Table 6. continued.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (±SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (±SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod and Pembina River Drainages									
Luscar Creek (EXP)	October 2000	4.2 ± 5.2	50.0	4.2 ± 3.7	50.0	Simulidae	19.0	Lumbricidae	47.6
						Tipulidae	19.0	Empididae	14.3
						Nemouridae	14.3	Carabidae	9.5
						Chloroperlidae	14.3	Aphididae	4.8
						Diamesinae	9.5	Formicidae	4.8
						Baetidae	4.8	Araneae	4.8
	July 2001	16.2 ± 25.1	49.8	16.3 ± 9.6	50.2	Orthocladiinae	60.5	Baetidae	46.6
						Diamesinae	21.0	Empididae	14.7
						Simulidae	4.3	Hymenoptera	6.1
						Limnaphellidae	2.5	Cicadellidae	5.5
						Rhyacophilidae	2.5	Muscomorpha	3.7
						Chironomini	1.9	Tipulidae	3.1
	August 2001	29.1 ± 18.9	67.2	14.2 ± 13.6	32.8	Diamesinae	19.6	Empididae	50.7
						Collembola	15.8	Cicadellidae	13.4
						Orthocladiinae	14.8	Muscomorpha	4.2
						Siphlonuridae	11.0	Hemiptera	2.1
						Nemouridae	8.9	Coleoptera	2.1
						Rhyacophilidae	4.1	Trichoptera	2.1
	September 2001	21.2 ± 10.5	83.8	4.1 ± 5.2	16.2	Baetidae	26.4	Chironomidae	26.8
						Chironomidae	20.8	Ephemeroptera	24.4
						Diamesinae	11.8	Baetidae	22.0
						Simulidae	10.4	Rhyacophillidae	19.5
						Ephemerellidae	8.5		
						Perlodidae	3.8		
Gregg River (EXP)	October 2000	2.3 ± 2.3	81.8	0.5 ± 0.7	18.2	Perlodidae	22.2	Formicidae	50.0
						Ephemeroptera	18.5	Hymenoptera	33.3
						Orthocladiinae	11.1	Muscomorpha	16.7
						Heptageniidae	7.4		
						Tipulidae	7.4		
						Chloroperlidae	7.4		

(continued)

Table 6. concluded.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (±SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (±SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod and Pembina River Drainages									
Gregg River (EXP)	July 2001	15.2 ± 12.6	68.5	7.0 ± 8.7	31.5	Simulidae	40.8	Empididae	28.6
						Orthocladiinae	18.4	Baetidae	14.3
						Heptageniidae	10.5	Cicadellidae	11.4
						Siphlonuridae	10.5	Lepidoptera	8.6
						Dytiscidae	3.9	Ephemeroptera	5.7
						Amelitidae	3.9	Plecoptera	5.7
	September 2001	15.3 ± 6.6	88.4	2.0 ± 1.9	11.6	Nemouridae	24.2	Hymenoptera	15.0
						Baetidae	20.3	Perlodidae	10.0
						Perlodidae	17.6	Ephemeroptera	10.0
						Orthocladiinae	5.2	Diptera	10.0
						Heptagenidae	5.2	Formicidae	10.0
						Ephemerellidae	3.9	Nemouridae	5.0
Smoky River Drainage									
Muskeg River (REF)	October 2000	4	16.0	21	84.0	Limnaphelidae	50.0	Bibionidae	66.7
						Brachycentridae	25.0	Chironomidae	14.3
						Heptageniidae	25.0	Simulidae	9.5

REF Reference site
EXP Exposure site

Table 7. Mean volume (%) (±SD) of food items in brook trout stomachs, 2000-2001.

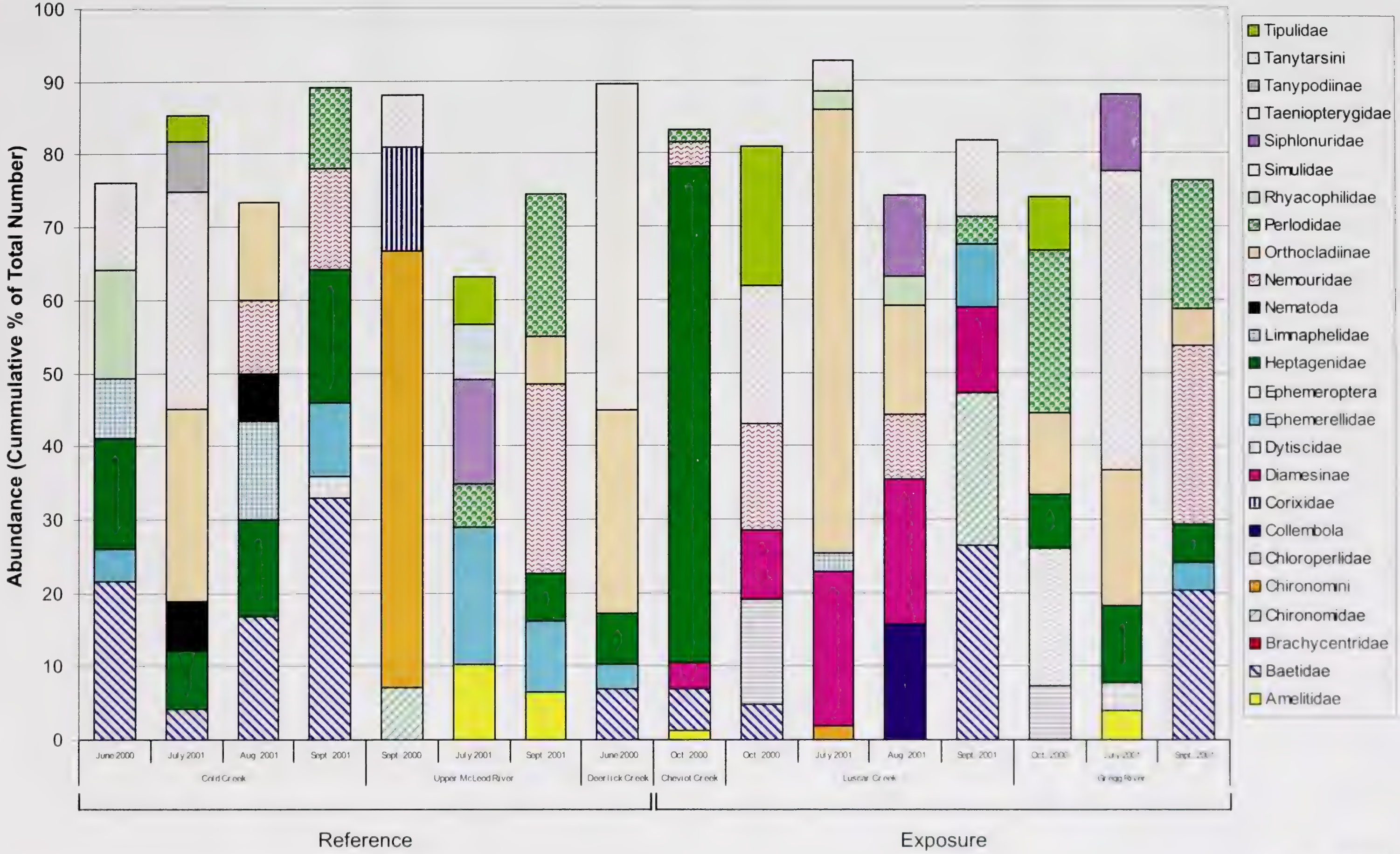
Waterbody	Sample Date	Terrestrial Invertebrates	Unidentified Fish	Aquatic Invertebrates	Organic Detritus	Inorganic Material	Unidentified Detritus
McLeod and Pembina River Drainages							
Fairfax Lake (REF)	December 2000	0	0	84.8 ± 19.2	15.3 ± 19.2	0	0
Cold Creek (REF)	June 2000	39.9 ± 20.7	0	57.5 ± 21.8	2.3 ± 3.3	0.4 ± 1.1	0
	July 2001	56.7 ± 23.4	0	39.3 ± 24.1	4.0 ± 9.7	0	0
	August 2001	82.1 ± 29.1	0	8.0 ± 9.7	9.8 ± 29.3	0	0
	September 2001	57.2 ± 34.4	0	37.3 ± 29.1	5.1 ± 12.5	0.4 ± 1.3	0
Upper McLeod River (REF)	September 2000	51.5 ± 47.0	0	37.7 ± 39.7	10.8 ± 26.5	0	0
	July 2001	14.6 ± 23.8	0	82.8 ± 25.4	2.0 ± 3.3	0.7 ± 2.0	0
	September 2001	11.8 ± 26.4	0	30.2 ± 33.6	58.0 ± 45.9	0	0
Deerlick Creek (REF)	June 2000	22.0	0	70.0	8.0	0	0
Cheviot Creek (REF)	October 2000	1.7 ± 3.7	0	69.0 ± 35.4	25.0 ± 38.2	4.3 ± 11.3	0
Luscar Creek (EXP)	June 2000	64.2 ± 43.2	0.2 ± 0.4	33.6 ± 39.4	2.0 ± 4.5	0	0
	July 2001	67.1 ± 15.6	0	25.9 ± 17.2	5.5 ± 10.7	1.5 ± 4.7	0
	August 2001	43.2 ± 28.9	0	55.2 ± 27.9	0.6 ± 1.3	1.0 ± 1.9	0
	September 2001	22.2 ± 28.1	0	75.4 ± 30.2	0.9 ± 1.7	1.5 ± 2.6	0
Gregg River (EXP)	October 2000	5.6 ± 7.5	5.5 ± 17.4	68.6 ± 34.6	20.3 ± 34.3	0	0
	July 2001	35.8 ± 13.1	0	64.2 ± 13.1	0	0	0
	September 2001	25.2 ± 24.0	0	67.1 ± 18.8	7.1 ± 7.6	0.6 ± 1.9	0
Smoky River Drainage							
Muskeg River (REF)	October 2000	60.0	0	17.0	20.0	3.0	0

REF Reference site
EXP Exposure site

Table 8. Mean dry weight (mg) and % (±SD) composition of food items in brook trout stomachs, 2000-2001.

Waterbody	Sample Date	Terrestrial & Aquatic Invertebrates		Unidentified Fish		Organic Detritus		Inorganic Material		Unidentified Detritus	
		Weight	%	Weight	%	Weight	%	Weight	%	Weight	%
McLeod and Pembina River Drainages											
Fairfax Lake (REF)	December 2000	158.04 ± 83.62	84.5	0	0	51.42 ± 71.30	15.6	0	0	0	0
Cold Creek (REF)	June 2000	84.16 ± 57.25	96.3	0	0	0.96 ± 1.55	1.9	0.58 ± 1.64	1.8	0	0
	July 2001	14.77 ± 16.13	96.3	0	0	0.34 ± 1.04	3.7	0	0	0	0
	August 2001	91.98 ± 157.88	89.6	0	0	3.09 ± 7.53	10.0	0	0	0.20 ± 0.50	0.4
	September 2001	51.57 ± 50.27	92.4	0	0	0.29 ± 0.57	6.7	0.73 ± 2.30	1.0	0	0
Upper McLeod River (REF)	September 2000	14.25 ± 11.14	86.1	0	0	1.24 ± 3.03	14.0	0	0	0	0
	July 2001	56.56 ± 69.72	95.8	0	0	0.81 ± 1.35	2.8	0.13 ± 0.39	1.4	0	0
	September 2001	12.52 ± 19.35	37.3	0	0	53.04 ± 74.51	62.7	0	0	0	0
Deerlick Creek (REF)	June 2000	23.81	83.6	0	0	4.67	16.4	0	0	0	0
Cheviot Creek (REF)	October 2000	27.02 ± 48.08	61.6	0	0	3.10 ± 5.01	32.0	0.35 ± 0.60	6.5	0	0
Luscar Creek (EXP)	October 2000	103.34 ± 96.17	97.9	0.02 ± 0.040	0	0.20 ± 0.44	2.0	0	0	0	0
	July 2001	16.83 ± 13.33	86.6	0	0	7.80 ± 20.64	13.4	0	0	0	0
	August 2001	45.92 ± 41.38	96.2	0	0	0.12 ± 0.30	1.1	2.97 ± 8.45	3.3	0	0
	September 2001	15.99 ± 17.59	83.8	0	0	0.50 ± 0.93	1.0	8.59 ± 13.89	15.2	0	0
Gregg River (EXP)	October 2000	6.51 ± 8.03	69.9	0	0	1.23 ± 3.89	8.0	1.49 ± 3.80	22.1	0	0
	July 2001	15.06 ± 13.14	100.0	0	0	0	0	0	0	0	0
	September 2001	22.97 ± 27.20	90.2	0	0	1.74 ± 3.18	9.4	0.02 ± 0.07	0.5	0	0
Smoky River Drainage											
Muskeg River (REF)	October 2000	26.85	62.9	0	0	12.73	29.8	3.09	7.2	0	0

REF	Reference site
EXP	Exposure site



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ALBERTA ENVIRONMENT

FISH DIET ANALYSIS

Figure No.

4.0

Title

Brook Trout Stomach Contents
Aquatic Invertebrates
McLeod River Drainage

the stoneflies *Zapada* sp. (Nemouridae) and *Isoperla* sp. (Perlodidae) and the chironomid *Sergentia* sp. were the most common aquatic invertebrates in brook trout from the upper McLeod River. In Luscar Creek, fish fed mostly on simulids, chironomids (Diamesinae [*Diamesa* sp. and *Pagastia* sp.]) and tipulids (*Tipula* sp. and *Dicranota* sp.). There was no consistent preference in prey items in brook trout from either of these streams, both among the months sampled and between years.

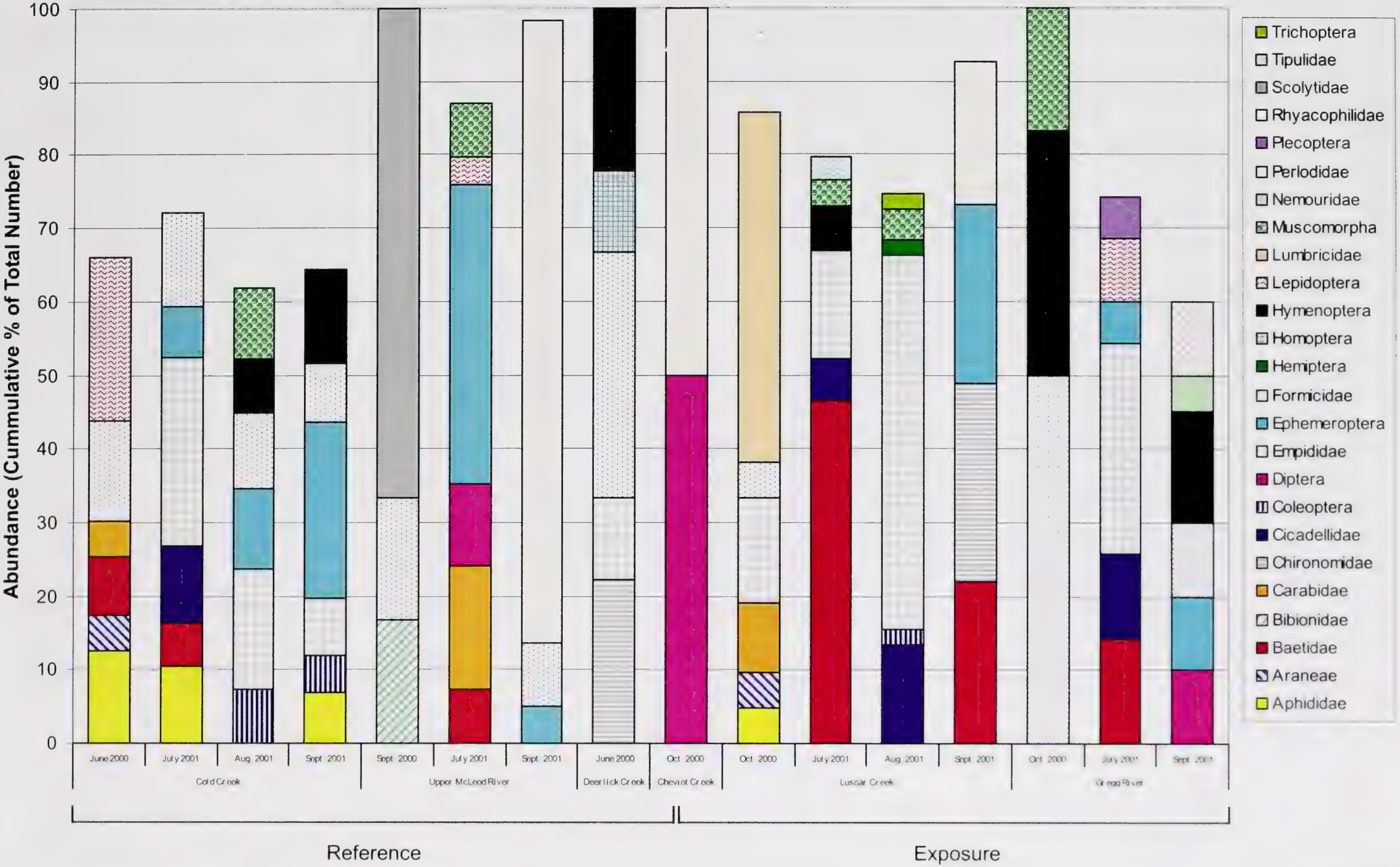
Brook trout fed on a variety of terrestrial invertebrates with no consistent trend in diet preference (Figure 5). Mayflies (Ephemeroptera and Baetidae [*Baetis* sp.]) ants (Formicidae) and dance flies (Empididae) were commonly found in the diet of brook trout from most streams (Table 6).

Terrestrial and aquatic invertebrates formed the bulk of the diet of brook trout by both volume and weight from streams within the reference and exposure areas (Tables 7 and 8). Typically, invertebrates accounted for 60 to 95% of the volume and weight of food items in brook trout. Fish from reference streams had a higher volume of terrestrial invertebrates than fish from exposure stream. Conversely exposure fish consumed a larger volume of aquatic invertebrates than reference fish.

Fish formed part of the diet of brook trout from only Luscar Creek and the Gregg River; however, the proportion of fish in the diet based on both volume and weight, was very low and was typically represented by a few fish scales (Tables 7 and 8).

Monthly sampling was done in some years in a few streams. Differences in the volume of terrestrial and aquatic invertebrates in brook trout diet were found in the four streams (Cold Creek, Upper McLeod River, Luscar Creek, Gregg River) where monthly sampling was done (Table 7). In Cold Creek, lower numbers of terrestrial invertebrates were consumed by brook trout in June 2000 than in other months. In August 2001, a smaller volume of aquatic invertebrates was eaten by brook trout from Cold Creek compared to the other months where fish were sampled. In the upper McLeod River, the volume of aquatic invertebrates in brook trout diet was higher in July 2001 than in September 2000 and 2001. The mean volume of terrestrial and aquatic invertebrates was lower in Luscar Creek in September 2001 compared to the other months sampled in 2001 (Table 7). The mean volume of terrestrial invertebrates in the Gregg River was lower in October 2000 than in other months sampled.

Length, weight and age data for brook trout captured in streams within the McLeod River drainage are shown on Table 9. Fish from the reference sites ranged in age from 1 year to 3 years with an average age of 2.0 years while fish from exposure area streams ranged in age from 1 year to 7 years with an average of 2.8 years.



Client Project
ALBERTA ENVIRONMENT
FISH DIET ANALYSIS

Figure No.
5.0

Title
Brook Trout Stomach Contents
Terrestrial Invertebrates
McLeod River Drainage

Table 9. Mean length (mm), weight (g) and age (years) (±SD) of brook trout, 2000-2001.

Waterbody	Sample Date	Length (mm)	Weight (g)	Age (yrs.)	N	Sex Ratio[a]
McLeod and Pembina River Drainages						
Fairfax Lake (REF)	December 2000	258.1 ± 81.4	355.1 ± 517.6	2.3 ± 2.0	8	3:5:0
Cold Creek (REF)	October 2000	152.8 ± 25.1	33.3 ± 11.1	1.8 ± 0.7	8	5:3:0
	July 2001	169.9 ± 26.6	60.0 ± 29.1	NS	10	NS
	August 2001	162.6 ± 20.2	55.8 ± 28.4	NS	10	NS
	September 2001	181.0 ± 21.3	77.6 ± 28.2	NS	10	NS
Upper McLeod River (REF)	October 2000	179.5 ± 35.0	76.3 ± 44.1	2.3 ± 0.5	6	1:5:0
	July 2001	149.9 ± 14.8	40.6 ± 12.1	NS	9	NS
	September 2001	149.8 ± 43.9	45.7 ± 41.8	NS	5	NS
Deerlick Creek (REF)	October 2000	150	32.4	2	1	0:1:0
Cheviot Creek (REF)	October 2000	172.3 ± 63.3	95.5 ± 91.7	3.0 ± 2.0	12	5:1:6
Luscar Creek (EXP)	October 2000	204.0 ± 23.1	103.2 ± 41.3	3.8 ± 1.1	5	0:5:0
	July 2001	172.7 ± 39.6	76.2 ± 53.2	NS	10	NS
	August 2001	169.3 ± 13.0	62.6 ± 15.2	NS	10	NS
	September 2001	201.3 ± 18.3	103.8 ± 33.4	NS	10	NS
Gregg River (EXP)	October 2000	158.3 ± 33.9	56.3 ± 38.6	2.2 ± 1.0	12	8:4:0
	July 2001	149.4 ± 27.8	39.0 ± 21.6	NS	5	NS
	September 2001	157.4 ± 28.0	46.7 ± 27.7	NS	10	NS
Smoky River Drainage						
Muskeg River (REF)	October 2000	193	74	2	1	0:1:0

REF	Reference site
EXP	Exposure site
[a]	Ratio of males:females:immature
NS	Not sampled

3.2.2 Smoky River Drainage

Only one brook trout was captured in the Smoky River drainage, a two-year old female from the Muskeg River. Caddis fly larvae (Limnephilidae and *Brachycentrus* sp.], and mayflies (Heptageniidae [*Rhithrogena* sp.]) were the only aquatic invertebrates found in the stomach (Table 6). Terrestrial invertebrates in the diet were dominated by dipterans including march flies (Bibionidae), chironomids and simulids. Terrestrial invertebrates formed the majority of the volume of food items in the diet of this fish and invertebrates comprised over 60% of the total weight of food items (Tables 7 and 8).

3.3 BULL TROUT

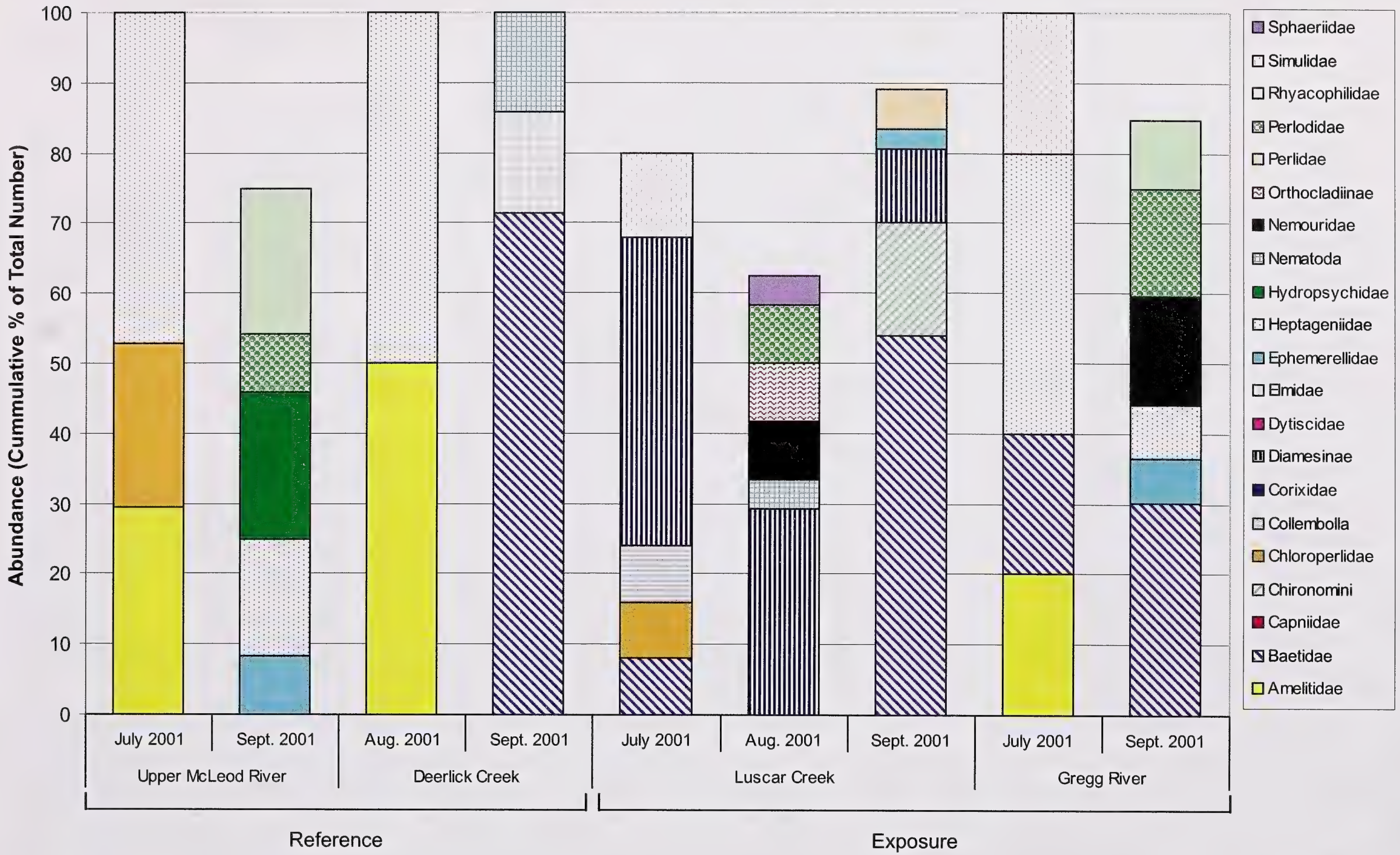
3.3.1 McLeod River Drainage

3.3.1.1 Streams

Bull trout were collected from two reference streams (upper McLeod River and Deerlick Creek) and two exposure streams (Luscar Creek and the Gregg River) from within the McLeod River drainage. The invertebrate component of the diet of bull trout from reference and exposure streams was quite variable both seasonally and between streams with no clear trend evident in food preferences (Figures 6 and 7). Numerically, aquatic invertebrates formed a larger part of the bull trout diet than terrestrial invertebrates except in Deerlick Creek in September 2001 (Table 10). Mayflies (Ameltidae [*Ameletus* sp.], Baetidae [*Baetis* sp.], Heptageniidae [*Cinygmula* sp. and *Epeorus* (Iron) sp.]) and caddisflies (Rhyacophiliidae [*Rhyacophila* sp.] and Hydropsychidae [*Parapsyche* sp.]) were the most common food item in bull trout stomachs from the Upper McLeod River and Deerlick Creek reference areas and the Gregg River exposure area in July 2001. In Luscar Creek, the diversity of aquatic invertebrates in bull trout diet was quite variable. Chironomids (Diamesinae [*Diamesa* sp. *Pagastia* sp. *Potthastia gaedii gp.* sp., *Pseudodiamesa* sp.]), mayflies (Baetidae [*Baetis* sp.]), and simulids were the dominant aquatic invertebrate in bull trout diet.

Bull trout fed on a variety of terrestrial invertebrates with no consistent pattern in the preference for certain invertebrate prey items (Figure 7). In the upper McLeod River, flies (Muscomorpha) were the only terrestrial invertebrate in the diet of bull trout. In Deerlick Creek, mayflies (Ephemeroptera), aphids (Psillidae) and dance flies (Empididae) were commonly found in the diet of bull trout (Table 10). The major terrestrial invertebrate components in the diet of bull trout from Luscar Creek and the Gregg River were mayflies (Ephemeroptera, Baetidae [*Baetis* sp.], flies (Muscomorpha), caddisflies (Rhyacophiliidae [*Rhyacophila* sp.], and dance flies (Empididae).

Terrestrial and aquatic invertebrates formed the bulk of the diet of bull trout by both volume and weight from streams within the reference and exposure areas (Tables 11 and 12). Typically, invertebrates accounted for >90% of the volume and weight of food items in bull trout. Fish formed part of the diet of bull trout from all streams in at least one sampling event except in



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McLeod River Drainage

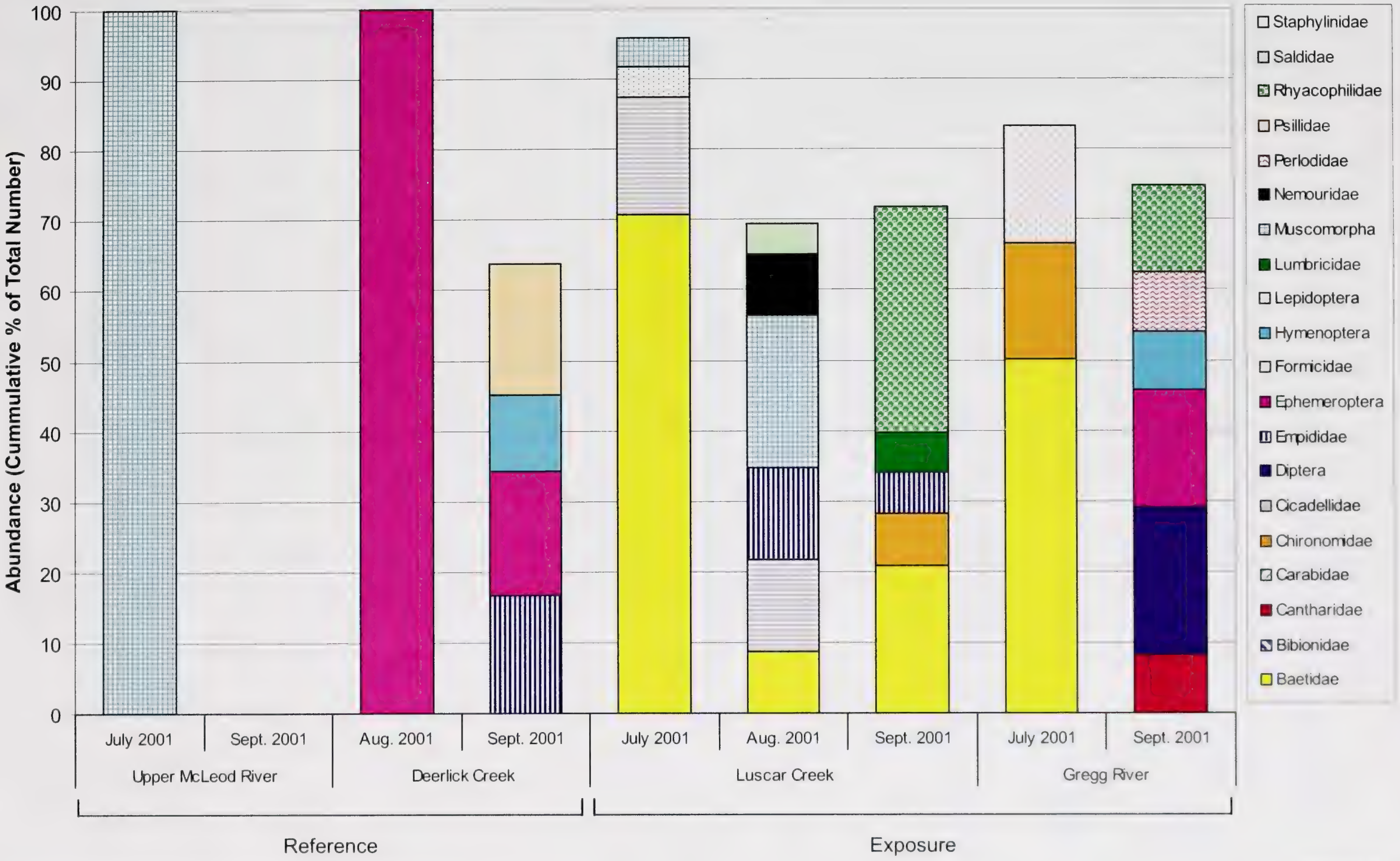

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Figure No.
7.0

Title
Bull Trout Stomach Contents
Terrestrial Invertebrates
McLeod River Drainage

Table 10. Invertebrate composition and abundance in bull trout diet, 2000-2001.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (±SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (±SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod River Drainage									
Upper McLeod R. (REF)	July 2001	17	94.4	1	5.6	Heptageniidae	47.1	Muscomorpha	100.0
						Amelitidae	29.4		
						Chloroperlidae	23.5		
	September 2001	12.0 ± 2.8	100.0	0	0	Rhyacophilidae	20.8	-	-
						Hydropsychidae	20.8		
						Heptageniidae	16.7		
						Perlodidae	8.3		
						Ephemerellidae	8.3		
Deerlick Creek (REF)	August 2001	2	50	2	50	Amelitidae	50.0	Ephemeroptera	100.0
						Heptageniidae	50.0		
	September 2001	7	6.4	102	93.6	Baetidae	71.4	Psillidae	18.6
						Nematoda	14.3	Ephemeroptera	17.6
						Elmidae	14.3	Empididae	16.7
								Hymenoptera	10.8
Luscar Creek (EXP)	July 2001	3.1 ± 4.3	51.0	3.0 ± 2.8	49.0	Diamesinae	44.0	Baetidae	70.8
						Simulidae	12.0	Cicadellidae	16.7
						Collembolla	8.0	Lepidoptera	4.2
						Chloroperlidae	8.0	Muscornorpha	4.2
						Baetidae	8.0		
	August 2001	3.4 ± 3.0	51.1	3.3 ± 7.0	48.9	Diamesinae	29.2	Muscomorpha	21.7
						Nemouridae	8.3	Empididae	13.0
						Perlodidae	8.3	Cicadellidae	13.0
						Orthocladiinae	8.3	Baetidae	8.7
						Sphaeriidae	4.2	Nemouridae	8.7
						Nematoda	4.2	Saldidae	4.3
	September 2001	49.3 ± 41.6	90.3	5.3 ± 4.6	9.7	Baetidae	54.0	Rhyacophilidae	32.1
						Chironomini	16.0	Baetidae	20.8
						Diamesinae	10.5	Chironomidae	7.5
						Perlodidae	5.5	Empididae	5.7
						Ephemerellidae	3.0	Lumbricidae	5.7

(continued)

Table 10. concluded.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (±SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (±SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod River Drainage									
Gregg River (EXP)	July 2001	7.6 ± 2.6	71.4	2.0 ± 1.7	28.6	Heptageniidae	40.0	Baetidae	50.0
						Baetidae	20.0	Chironomidae	16.7
						Amelitidae	20.0	Empididae	16.7
						Simulidae	20.0	Staphylinidae	16.7
	September 2001	14.3 ± 6.2	85.6	2.4 ± 3.5	14.4	Baetidae	30.1	Diptera	20.8
						Nemouridae	15.4	Ephemeroptera	16.7
						Perlodidae	15.4	Rhyacophilidae	12.5
						Rhyacophilidae	9.8	Perlodidae	8.3
						Heptageniidae	7.7	Cantharidae	8.3
						Ephemerellidae	6.3	Hymenoptera	8.3
Smoky River Drainage									
Muskeg River (REF)	October 2000	8.6 ± 7.0	95.4	0.4 ± 0.9	4.6	Ephemerellidae	38.8	Bibionidae	60.0
						Heptageniidae	19.4	Muscomorpha	20.0
						Baetidae	15.5	Carabidae	20.0
						Capniidae	7.8		
						Perlodidae	7.8		
Sheep Creek (EXP)	October 2000	4.8 ± 13.9	22.6	16.3 ± 41.4	77.4	Orthocladiinae	73.7	Bibionidae	76.4
						Ephemerellidae	7.0	Chironomidae	9.7
						Perlodidae	5.3	Ephemeroptera	3.6
						Perlidae	3.5	Formicidae	2.6
Beaverdam Creek (EXP)	October 2000	2.8 ± 2.6	82.5	0.6 ± 1.0	17.5	Perlodidae	36.4	Bibionidae	85.7
						Nemouridae	18.2	Lepidoptera	14.3
						Baetidae	9.1		
						Ephemerellidae	9.1		
						Hydropsychidae	9.1		
						Heptageniidae	6.1		
Smoky River (EXP)	September 2000	0.8 ± 1.2	100	0	0	Corixidae	62.5	-	-
						Heptageniidae	12.5		
						Hydropsychidae	12.5		
						Dytiscidae	12.5		

Table 11. Mean volume (%) (±SD) of food items in bull trout stomachs, 2000-2001.

Waterbody	Sample Date	Terrestrial Invertebrates	Unidentified Fish/Mammals	Aquatic Invertebrates	Organic Detritus	Inorganic Material	Unidentified Detritus
McLeod River Drainage							
Upper McLeod River (REF)	July 2001	0.1	0	99.9	0	0	0
	September 2001	0	27.5 ± 38.9	71.5 ± 37.5	1.0 ±1.4	0	0
Deerlick Creek (REF)	August 2001	0	0	100	0	0	0
	September 2001	89	0	4	7	0	0
Luscar Creek (EXP)	July 2001	50.0 ± 35.6	0	42.5 ± 37.8	7.4 ± 13.8	0.1 ± 0.4	0
	August 2001	28.0 ± 39.0	0	71.3 ± 38.9	0.7 ± 1.9	0	0
	September 2001	24.5 ± 28.3	0.4 ± 1.0	66.3 ± 28.4	7.3 ± 13.9	1.0 ± 1.7	0.5 ± 1.6
Gregg River (EXP)	July 2001	25.0 ± 25.0	0	70.0 ± 32.8	0	5.0 ± 8.7	0
	September 2001	27.0 ± 31.1	0.1 ± 0.3	67.3 ± 34.9	0.6 ± 1.6	0	0
Smoky River Drainage							
Muskeg River (EXP)	October 2000	2.3 ± 4.2	0	96.9 ± 4.8	0.4 ± 1.4	0.4 ± 1.4	0
Sheep Creek (EXP)	October 2000	40.0 ± 39.7	11.5 ± 11.0	43.8 ± 39.1	3.4 ± 5.2	1.4 ± 3.9	0
Beaverdam Creek (EXP)	October 2000	15.6 ± 31.3	0	73.7 ± 39.7	1.4 ± 4.5	9.3 ± 30.1	0
Smoky River (EXP)	September 2000	75.6 ± 42.4	20.6 ± 44.4	0	3.8 ± 3.4	0	0

REF	Reference site
EXP	Exposure site

Table 12. **Mean dry weight (mg) and % composition (±SD) of food items in bull trout stomachs, 2000-2001.**

Waterbody	Sample Date	Terrestrial & Aquatic Invertebrates		Unidentified Fish		Organic Detritus		Inorganic Material		Unidentified Detritus	
		Weight	%	Weight	%	Weight	%	Weight	%	Weight	%
McLeod River Drainage											
Upper McLeod River (REF)	July 2001	14.27	100	0	0	0	0	0	0	0	0
	September 2001	51.99 ± 61.97	69.8	5.98 ± 8.45	29.7	0.46 ± 0.65	0.5	0	0	0	0
Deerlick Creek (REF)	August 2001	1.98	100	0	0	0	0	0	0	0	0
	September 2001	54.59	91.5	0	0	0.51	8.5	0	0	0	0
Luscar Creek (EXP)	July 2001	3.82 ± 3.44	89.7	0	0	0.33 ± 0.64	0.9	0.04 ± 0.12	0.5	0	0
	August 2001	5.42 ± 5.71	99.2	0	0	0.03 ± 0.08	0.8	0	0	0	0
	September 2001	51.44 ± 36.75	86.5	0.31 ± 0.59	0.4	2.88 ± 3.20	9.0	2.98 ± 4.71	3.2	0.18 ± 0.57	1.0
Gregg River (EXP)	July 2001	4.74 ± 2.55	79.8	0	0	0	0	9.2 ± 1.60	20.2	0	0
	September 2001	9.53 ± 4.02	99.2	0.02 ± 0.06	0.2	0.08 ± 0.24	0.5	0	0	0	0
Smoky River Drainage											
Muskeg River (REF)	October 2000	14.32 ± 21.23	95.6	0	0	0.14 ± 0.48	0.2	0.66 ± 2.27	4.2	0	0
Sheep Creek (EXP)	October 2000	25.69 ± 39.28	63.6	75.02 ± 213.72	21.1	3.06 ± 7.69	10.2	3.48 ± 10.69	5.1	0	0
Beaverdam Creek (EXP)	October 2000	12.80 ± 18.27	89.7	0	0	0.06 ± 0.19	0.8	1.54 ± 4.75	9.5	0	0
Smoky River (EXP)	September 2000	293.32 ± 330.90	61.5	236.07 ± 386.14	22.0	22.07 ± 25.04	4.6	199.38 ± 488.39	12.0	0	0

REF	Reference site
EXP	Exposure site

Deerlick Creek (Table 11 and 12). However, the proportion of fish in the diet by both volume and weight was very low and fish were not part of the diet during all sampling events.

Bull trout from the reference streams (Upper McLeod River and Deerlick Creek) had lower weights of terrestrial and aquatic invertebrates in their diet than fish from exposure streams.

Monthly sampling was done in both reference and exposure area streams; however, small sample sizes from both of the reference sampling sites (upper McLeod River and Deerlick Creek) precluded any detailed analyses. In Luscar Creek and the Gregg River, no major differences in the volume of any diet component were observed in exposure fish (Table 11). However, the weight of food items was higher in the fall (September) than during the summer months (Table 12).

Length and weight data for bull trout captured in streams within the McLeod River drainage are shown on Table 13. No age data were collected for fish from these streams.

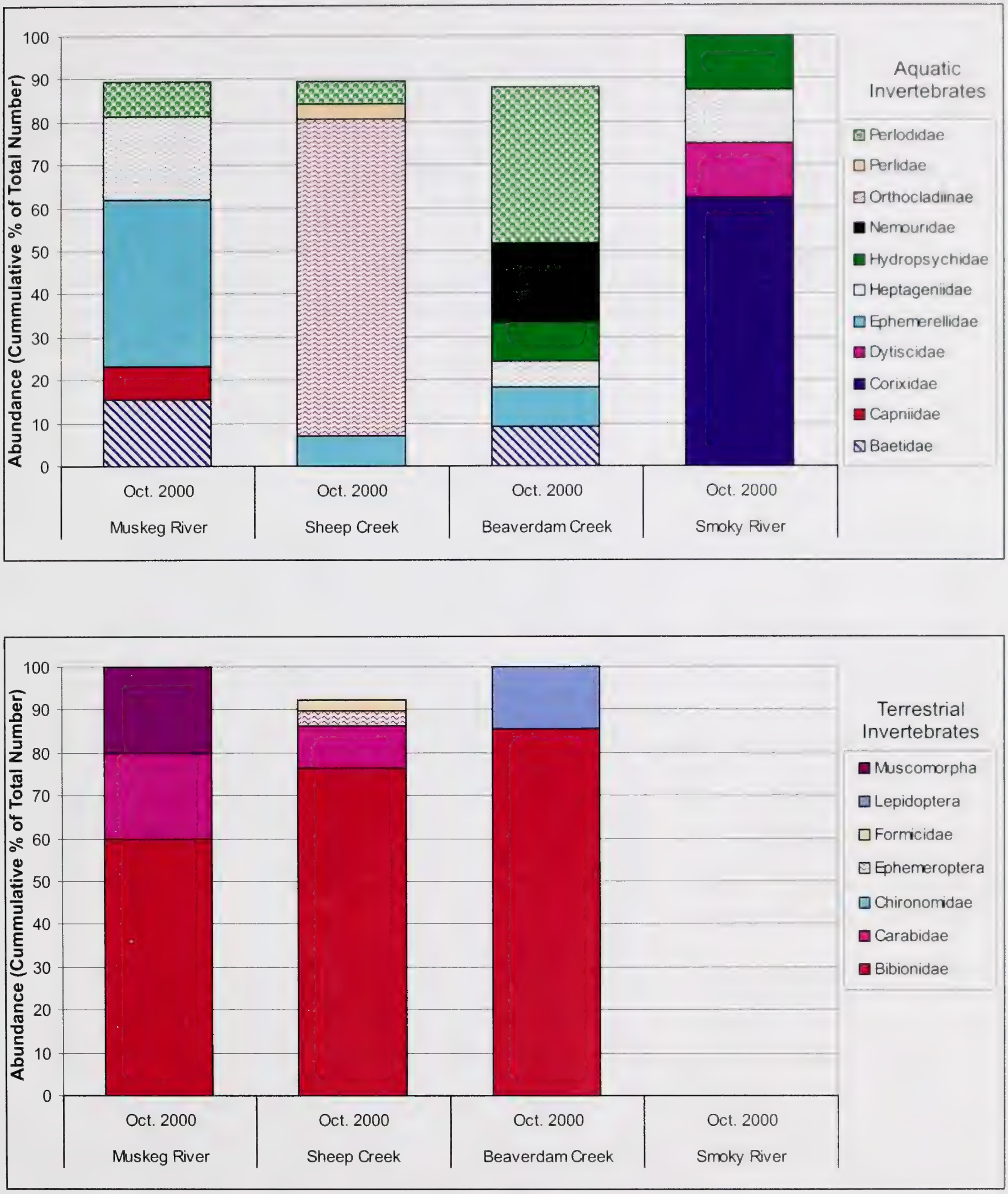
3.3.2 Smoky River Drainage

Bull trout were collected from one reference stream (Muskeg River) and three exposure streams (Sheep Creek, Beaverdam Creek, Smoky River) from within the Smoky River drainage. The invertebrate component of the diet of bull trout from reference and exposure streams was quite variable with no clear trend evident in food preferences (Figure 8 and Table 10). Numerically, aquatic invertebrates formed a larger part of the bull trout diet than terrestrial invertebrates except in Sheep Creek (Table 10). Mayflies (Ephemerellidae [*Drunella doddsi*, *Drunella grandis ingens*], Heptageniidae [*Cinygmula* sp. and *Epeorus* (Iron) sp.], Baetidae [*Baetis* sp.],) were the most common food item in bull trout stomachs from the Muskeg River reference area. In Sheep Creek, chironomids (Orthocladiinae [*Criciotopus* or *Orthocladius* sp. were the dominant aquatic invertebrates in bull trout diet while in Beaverdam Creek, stonefly larvae (Perlodidae [*Isoperla* sp.] and Nemouridae [*Zapada* sp.] were the dominant aquatic food item. Water boatmen (Corixidae [*Callicorixa audeni*]) were the most abundant food item in bull trout stomachs from the Smoky River (Table 10).

The dipteran march flies (Bibionidae) were the dominant terrestrial invertebrates in the bull trout diet (Figure 8 and Table 10). Lesser amounts of chironomids, flies (Muscomorpha) and butterflies and moths (Lepidoptera) were in the diet of bull trout.

Terrestrial and aquatic invertebrates formed the bulk of the diet of bull trout by both volume and weight from streams within the reference and exposure areas (Tables 11 and 12). Typically, invertebrates accounted for >85% of the volume and weight of food items in bull trout.

Based on volume, fish formed 11 to 20% of the diet of bull trout from Sheep Creek and the Smoky River whereas they were absent from the diet of trout from the Muskeg River reference area and Beaverdam Creek (Table 11). No comparisons could be made for the weight of fish in the diet of bull trout since they were absent from the stomachs of reference area fish.



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FISH DIET ANALYSIS

Figure No.
8.0

Title
Bull Trout Stomach Contents
Smoky River Drainage

No seasonal comparisons of bull trout diet could be made since no seasonal sampling was done in either reference or exposure area streams.

Length, weight and age data for bull trout captured in streams within the Smoky River drainage are shown on Table 13. Fish from the reference sites ranged in age from 1 year to 3 years with an average age of 1.7 years while fish from exposure area streams ranged in age from 1 year to 10 years with an average of 5.2 years (Table 13).

3.4 MOUNTAIN WHITEFISH

3.4.1 McLeod River Drainage

3.4.1.1 Streams

Mountain whitefish were collected from two reference streams (upper McLeod River and McKenzie Creek) and three exposure streams (Luscar Creek, middle McLeod River and the Gregg River) from within the McLeod River drainage. The invertebrate component of the diet of mountain whitefish from reference and exposure streams was quite variable both seasonally and between streams with no clear trend evident in a preference for feeding on particular taxa (Figures 9 and 10, Table 14). Numerically, aquatic invertebrates formed a large majority of the mountain whitefish diet with only relatively small numbers of terrestrial invertebrates (Table 14). Mayflies (Ephemerellidae [*Drunella doddsi*, *Drunella coloradensis*, *Drunella grandis ingens*.], Baetidae [*Baetis* sp.], simulids (Simulidae) and chironomids (Orthocladiinae [*Criciotopus* or *Orthocladius* sp, *Brillia* sp.]) were the most common food item in mountain whitefish stomachs from the Upper McLeod River. In MacKenzie Creek, mountain whitefish fed almost exclusively on *Baetis* sp. Chironomids (Diamesinae [*Pagastia* sp. *Potthastia gaedii gp.* sp., *Pseudodiamesa* sp.]), mayflies (Baetidae [*Baetis* sp.]), and simulids were the dominant aquatic invertebrate in mountain whitefish from these streams.

Mountain whitefish fed on a variety of terrestrial invertebrates with no consistent pattern evident of a preference to particular taxa (Figure 10 and Table 14). In the upper McLeod River in July 2001, dance flies (Empididae) were the only terrestrial invertebrate in the diet of mountain whitefish. In September 2000 and 2001, Hymenoptera, stoneflies (Chloroperlidae), aphids and caddisfly larvae (Rhyacophillidae) comprised most of the kinds of terrestrial invertebrates in mountain whitefish diet. In McKenzie Creek, flies (Muscomorpha), bees/wasps (Hymenoptera) and gnats (Mycetophylidae) were the only terrestrial invertebrates in mountain whitefish stomachs. Mayflies (Ephemeroptera, Baetidae [*Baetis* sp.), simulids, aphids (Aphididae), and leaf hoppers (Cicadellidae) were the most common terrestrial invertebrates found in the diet of mountain whitefish from exposure area streams.

Terrestrial and aquatic invertebrates formed the bulk of the diet of mountain whitefish by both volume and weight from streams within the reference and exposure areas (Tables 15 and 16). Typically, invertebrates accounted for 80 to 95% of the volume and weight of food items in mountain whitefish.

Table 13. **Mean length (mm), weight (g) and age (years) (±SD) of bull trout, 2000-2001.**

Waterbody	Sample Date	Length (mm)	Weight (g)	Age (yrs.)	N	Sex Ratio[a]
McLeod River Drainage						
Upper McLeod River (REF)	July 2001	139.7 ± 25.7	28.2 ± 14.1	NS	3	NS
	September 2001	169.0 ± 42.3	56.2 ± 49.7	NS	3	NS
Deerlick Creek (REF)	August 2001	173	56.8	NS	1	NS
	September 2001	243	154.4	NS	1	NS
Luscar Creek (EXP)	July 2001	219.0 ± 30.3	108.7 ± 39.8	NS	8	NS
	August 2001	158.5 ± 21.8	39.6 ± 16.1	NS	10	NS
	September 2001	219.6 ± 42.4	114.9 ± 65.6	NS	10	NS
Gregg River (EXP)	July 2001	139.7 ± 25.7	28.2 ± 14.1	NS	3	NS
	September 2001	158.5 ± 21.8	39.6 ± 16.1	NS	10	NS
Smoky River Drainage						
Muskeg River (REF)	October 2000	137.4 ± 30.0	28.9 ± 19.9	1.7 ± 0.7	12	0:0:12
Sheep Creek (EXP)	October 2000	336.9 ± 51.0	392.9 ± 175.1	7.3 ± 1.8	11	1:8:3
Beaverdam Creek (EXP)	October 2000	131.5 ± 21.8	24.7 ± 11.7	1.9 ± 0.4	12	0:0:12
Smoky River (EXP)	October 2000	370.8 ± 76.4	616.0 ± 415.6	5.7 ± 1.8	6	1:2:3

REF Reference site
EXP Exposure site

[a] Ratio of males:females:immature
NS Not sampled

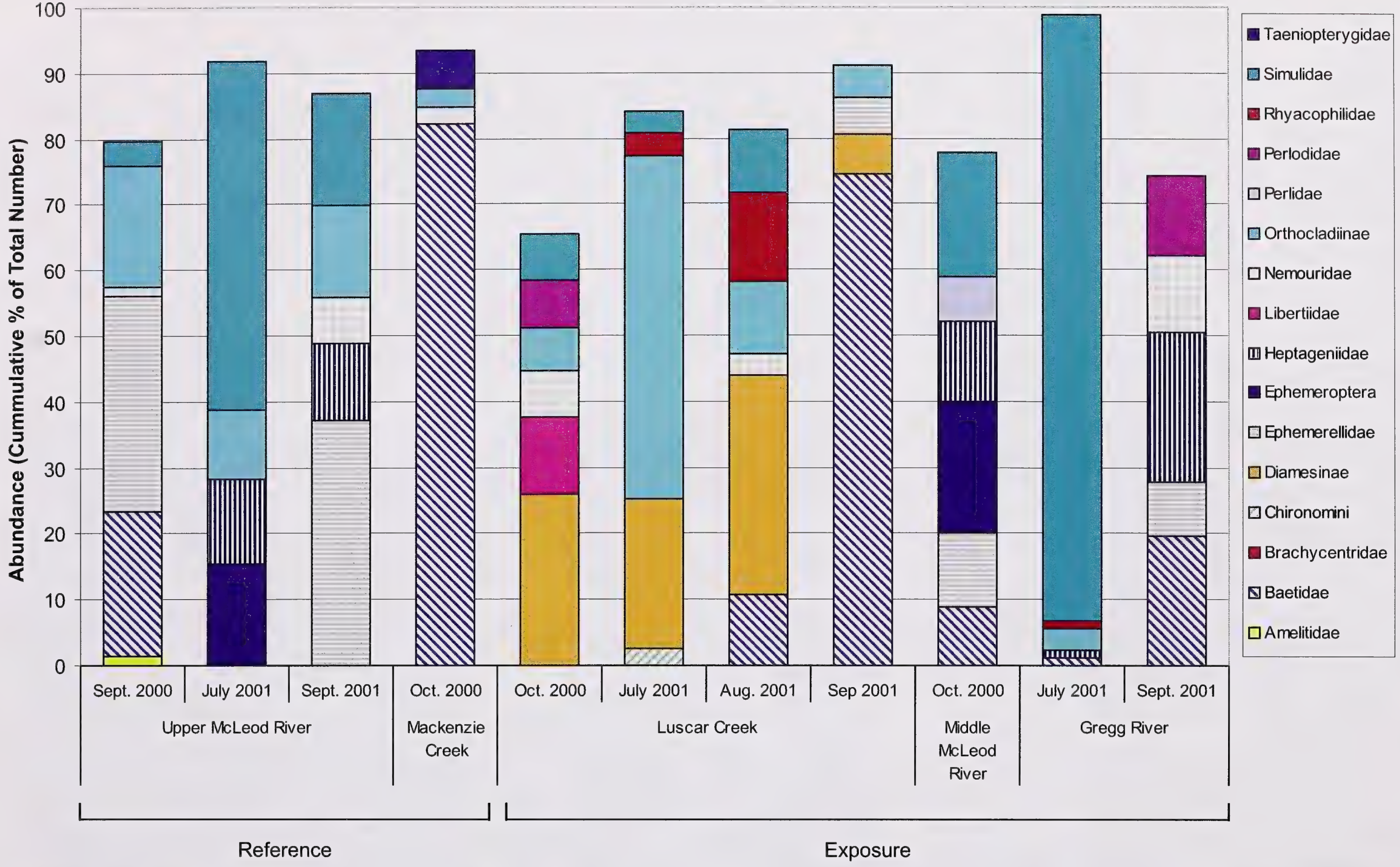

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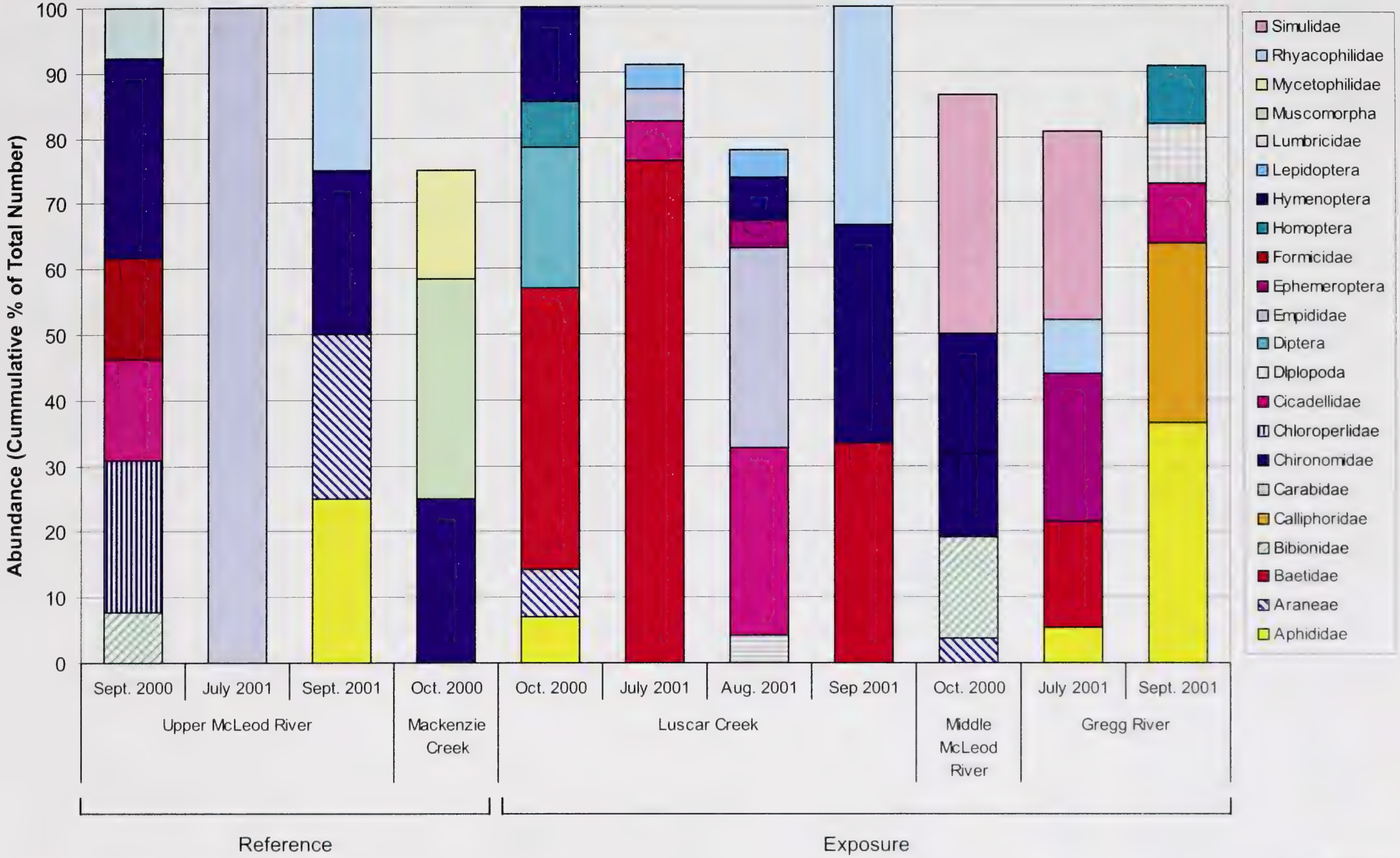
Figure No.
9.0

Title
Mountain Whitefish Stomach Contents Aquatic Invertebrates McLeod River Drainage



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Client Project
ALBERTA ENVIRONMENT
FISH DIET ANALYSIS

Figure No.
10.0

Title
Mountain Whitefish Stomach Contents Terrestrial Invertebrates McLeod River Drainage

Table 14. Invertebrate composition and abundance in mountain whitefish diet, 2000-2001.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (±SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (±SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod River Drainage									
Upper McLeod River (REF)	September 2000	42.0 ± 47.8	97.8	0.9 ± 1.9	2.2	Ephemerliidae	32.7	Hymenoptera	30.8
						Baetidae	21.9	Chloroperlidae	23.1
						Orthocladiinae	18.5	Cicadellidae	15.4
						Simulidae	3.7	Formicidae	15.4
						Amelitidae	1.4	Lumbricidae	7.7
						Nemouridae	1.4	Bibionidae	7.7
	July 2001	110.0 ± 116.0	99.1	1.0 ± 0.0	0.9	Simulidae	53.2	Empididae	100.0
						Ephemeroptera	15.5		
						Heptageniidae	12.7		
						Orthocladiinae	10.5		
	September 2001	38.7 ± 14.1	99.0	0.4 ± 0.7	1.0	Ephemerliidae	37.2	Hymenoptera	25.0
						Simulidae	17.1	Aphididae	25.0
						Orthocladiinae	14.0	Rhyacophilidae	25.0
						Heptageniidae	11.6	Araneae	25.0
						Nemouridae	7.0		
Mackenzie Creek (REF)	October 2000	171.0 ± 305.7	99.4	1.0 ± 1.5	0.6	Baetidae	82.3	Muscomorpha	33.3
						Taeniopterygidae	5.9	Hymenoptera	25.0
						Orthocladiinae	2.7	Mycetophilidae	16.7
						Nemouridae	2.6		
Luscar Creek (EXP)	October 2000	15.4 ± 9.1	93.9	1.0 ± 1.4	6.1	Diamesinae	26.0	Baetidae	42.9
						Libertiidae	11.6	Diptera	21.4
						Perlodidae	7.4	Hymenoptera	14.3
						Simulidae	7.0	Araneae	7.1
						Nemouridae	7.0	Homoptera	7.1
						Orthocladiinae	6.5	Aphididae	7.1
	July 2001	107.8 ± 120.1	82.6	22.7 ± 27.0	17.4	Orthocladiinae	52.2	Baetidae	76.5
						Diamesinae	22.6	Cicadellidae	5.9
						Rhyacophilidae	3.4	Empididae	5.1
						Simulidae	3.2	Lepidoptera	3.7
						Chironomini	2.6		

(continued)

Table 14. concluded.

Waterbody	Sample Date	Mean Number of Aquatic Invertebrates (±SD)	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates (±SD)	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
McLeod River Drainage									
Luscar Creek (EXP)	August 2001	64.1 ± 46.0	91.8	5.8 ± 6.2	8.2	Diamesinae	33.3	Empididae	30.4
						Rhyacophilidae	13.5	Cicadellidae	28.3
						Orthocladiinae	10.9	Hymenoptera	6.5
						Baetidae	10.7	Carabidae	4.3
						Simulidae	9.6	Lepidoptera	4.3
						Nemouridae	3.3	Ephemeroptera	4.3
	September 2001	70.1 ± 78.8	99.5	0.3 ± 0.7	0.5	Baetidae	74.6	Chironomidae	33.3
						Diamesinae	6.0	Baetidae	33.3
						Ephemerliidae	5.5	Rhyacophilidae	33.3
						Orthocladiinae	5.1		
Mid McLeod R. (EXP)	October 2000	7.5 ± 11.5	46.4	8.7 ± 9.2	53.6	Ephemeroptera	20.0	Simulidae	36.5
						Simulidae	18.9	Hymenoptera	18.3
						Heptageniidae	12.2	Bibionidae	15.4
						Ephemerliidae	11.1	Chironomidae	12.5
						Baetidae	8.9	Araneae	3.8
						Perlidae	6.7		
Gregg River (EXP)	July 2001	261.0 ± 371.8	97.7	7.1 ± 12.3	2.3	Simulidae	92.0	Simulidae	28.6
						Orthocladiinae	3.4	Ephemeroptera	22.4
						Heptageniidae	1.2	Baetidae	16.3
						Rhyacophilidae	1.1	Rhyacophilidae	8.2
						Baetidae	1.1	Aphididae	5.3
	September 2001	23.0 ± 25.0	95.4	1.1 ± 2.2	4.6	Heptageniidae	22.6	Aphididae	36.4
						Baetidae	19.6	Calliphoridae	27.3
						Perlodidae	12.2	Diplopoda	9.1
						Nemouridae	11.7	Cicadellidae	9.1
						Ephemerellidae	8.3	Homoptera	9.1
Smoky River Drainage									
Smoky River (EXP)	September 2000	198.0 ± 236.0	88.5	25.8 ± 46.5	11.5	Orthocladiinae	91.5	Bibionidae	74.8
						Brachycentridae	2.9	Hymenoptera	11.3
						Ephemerliidae	1.3	Formicidae	3.6
						Taeniopterygidae	0.9		

Table 15. Mean volume (%) (±SD) of food items in mountain whitefish stomachs, 2000-2001.

Waterbody	Sample Date	Terrestrial Invertebrates	Unidentified Fish/Mammals	Aquatic Invertebrates	Organic Detritus	Inorganic Material	Unidentified Detritus
McLeod River Drainage							
Upper McLeod River (REF)	September 2000	19.8 ± 35.7	0	68.8 ± 41.2	1.9 ± 5.2	9.5 ± 21.7	0
	July 2001	4.0 ± 2.8	0	95.5 ± 2.1	0.5 ± 0.7	0	0
	September 2001	1.0 ± 2.5	0	89.8 ± 12.8	3.6 ± 5.5	5.6 ± 10.9	0
Mackenzie Creek (REF)	October 2000	5.9 ± 10.5	0	92.8 ± 11.3	0.4 ± 1.2	0.8 ± 2.0	0
Luscar Creek (REF)	October 2000	12.4 ± 26.1	0	86.6 ± 26.2	0.4 ± 1.3	0.7 ± 2.7	0
	July 2001	33.2 ± 36.7	0	62.7 ± 36.1	4.2 ± 4.2	0	0
	August 2001	11.0 ± 8.9	0	84.6 ± 9.8	2.1 ± 2.9	2.3 ± 4.1	0
	September 2001	2.8 ± 6.7	1.1 ± 3.3	95.9 ± 7.2	0	0.2 ± 0.4	0
Mid McLeod River (REF)	October 2000	36.6 ± 20.4	0	57.9 ± 25.9	5.5 ± 13.9	0	0
Gregg River (REF)	July 2001	4.5 ± 8.0	0	89.5 ± 10.3	6.0 ± 8.2	0	0
	September 2001	3.0 ± 5.1	0	91.3 ± 10.9	2.9 ± 4.0	2.8 ± 7.9	0
Smoky River Drainage							
Smoky River (REF)	October 2000	30.2 ± 32.1	10.4 ± 20.3	34.0 ± 22.4	15.7 ± 12.6	6.8 ± 14.6	2.9 ± 10.1

REF	Reference site
EXP	Exposure site

Table 16. Mean dry weight (mg) and % composition (±SD) of food items in mountain whitefish stomachs, 2000-2001.

Waterbody	Sample Date	Terrestrial & Aquatic Invertebrates		Unidentified Fish		Organic Detritus		Inorganic Material		Unidentified Detritus	
		Weight	%	Weight	%	Weight	%	Weight	%	Weight	%
McLeod River Drainage											
Upper McLeod River (REF)	September 2000	42.37 ± 48.24	80.2	0	0	2.72 ± 7.79	3.1	22.80 ± 72.22	16.8	0	0
	July 2001	52.73 ± 29.17	99.2	0	0	0.62 ± 0.88	0.9	0	0	0	0
	September 2001	20.69 ± 25.74	82.4	0	0	2.22 ± 5.95	3.9	5.19 ± 13.95	13.7	0	0
Mackenzie Creek (REF)	October 2000	20.43 ± 16.05	97.0	0	0	0.12 ± 0.33	0.6	0.83 ± 1.95	2.4	0	0
Luscar Creek (EXP)	October 2000	14.38 ± 22.02	97.2	0	0	0.21 ± 0.78	0.2	0.51 ± 1.90	2.5	0	0
	July 2001	34.72 ± 27.30	95.9	0	0	2.09 ± 3.47	4.1	0	0	0	0
	August 2001	40.87 ± 26.18	85.5	0	0	2.04 ± 3.30	2.7	9.30 ± 16.82	11.9	0	0
	September 2001	43.35 ± 52.99	97.7	0.01 ± 0.19	1.9	0	0	0.39 ± 1.12	0.4	0	0
Mid McLeod River (EXP)	September 2000	19.08 ± 39.07	94.0	0	0	3.85 ± 11.30	6.0	0	0	0	0
Gregg River (EXP)	July 2001	137.06 ± 198.44	91.7	0	0	1.73 ± 2.05	8.4	0	0	0	0
	September 2001	6.50 ± 8.75	90.3	0	0	0.40 ± 0.75	3.7	0.24 ± 0.50	6.0	0	0
Smoky River Drainage											
Smoky River (EXP)	October 2000	101.09 ± 83.18	46.2	86.16 ± 182.59	11.2	78.57 ± 88.74	19.8	114.28 ± 264.08	18.6	12.68 ± 43.92	4.3

REF Reference site
EXP Exposure site

Monthly sampling was done in some years in a few streams. No monthly differences in the volume of terrestrial and aquatic invertebrates in mountain whitefish diet were found in the three streams (Upper McLeod River, Luscar Creek and Gregg River) where monthly sampling was done. The mean volume of organic detritus was higher in mountain whitefish stomachs from Luscar Creek in July and August 2001 compared to the other months sampled.

Length, weight and age data for mountain whitefish captured in streams within the McLeod River drainage are shown on Table 17. Fish from the reference sites ranged in age from 1 year to 7 years with an average age of 3.7 years while fish from exposure area streams ranged in age from 2 year to 8 years with an average of 3.4 years.

3.4.2 Smoky River Drainage

Mountain whitefish were only collected from the Smoky River exposure area. Numerically, aquatic invertebrates formed a large majority of the mountain whitefish diet with only relatively small numbers of terrestrial invertebrates (Table 14). Chironomids (Orthocladiinae [*Criciotopus* or *Orthocladius* sp, *Brillia* sp.]) were the most common aquatic invertebrate in the diet of mountain whitefish from the Smoky River. Far lesser numbers of caddisfly larvae (Brachycentridae [*Brachycentrus* sp.]) and mayflies (Ephemerellidae [*Drunella doddsi*] formed the diet of mountain whitefish.

The dipteran march flies (Bibionidae) were the dominant terrestrial invertebrates in the mountain whitefish. Lesser amounts of Hymenoptera and ants (Formicidae) were in the diet of mountain whitefish. Terrestrial and aquatic invertebrates formed the bulk of the diet of mountain whitefish by both volume and weight (Tables 15 and 16). Based on weight and volume, fish formed about 10% of the diet of mountain whitefish form the Smoky River. No seasonal comparisons of mountain whitefish diet could be made since no monthly sampling was done within a given year.

Length, weight and age data for mountain whitefish captured in the Smoky River are shown on Table 17. Average length of fish was 270 mm and average weight was 253 g. Fish ranged in age from 4 to 20 years with an average age of 6.8 years.

3.5 ARCTIC GRAYLING

Arctic grayling were captured only in the Smoky River. Numerically, terrestrial invertebrates formed a large majority of the Arctic grayling diet with only relatively small numbers of aquatic invertebrates (Table 18). Mayflies (Ephemeroptera) and chironomids (Orthocladiinae [*Criciotopus* or *Orthocladius* sp.]) were the most common aquatic invertebrate in the diet of Arctic grayling from the Smoky River. March flies (Bibionidae) were the dominant terrestrial invertebrates in the Arctic grayling diet with lesser amounts of Hymenoptera and ants (Formicidae). Terrestrial invertebrates formed the bulk of the diet of mountain whitefish by both volume and weight (Tables 19 and 20).

Table 17. Mean length (mm), weight (g) and age (years) of mountain whitefish, 2000-2001.

Waterbody	Sample Date	Length (mm)	Weight (g)	Age (yrs.)	N	Sex Ratio[a]
McLeod River Drainage						
Upper McLeod River (REF)	September 2000	292.4 ± 37.1	358.6 ± 161.5	4.5 ± 1.2	14	5:9:0
	July 2001	215.0 ± 2.8	123.0 ± 11.3	NS	2	NS
	September 2001	213.1 ± 35.3	126.9 ± 62.6	NS	10	NS
Mackenzie Creek (REF)	October 2000	193.6 ± 23.3	80.3 ± 28.6	2.1 ± 0.7	12	0:6:6
Luscar Creek (EXP)	June 2000	190.8 ± 26.1	85.9 ± 40.3	2.0 ± 0.6	14	2:0:12
	July 2001	254.7 ± 61.4	143.0 ± 22.5	NS	6	NS
	August 2001	240.6 ± 24.0	190.2 ± 56.1	NS	8	NS
	September 2001	180.2 ± 20.3	75.0 ± 27.9	NS	9	NS
Middle McLeod River (EXP)	October 2000	281.7 ± 51.6	313.5 ± 191.7	5.3 ± 1.5	12	3:9:0
Gregg River (EXP)	July 2001	235.1 ± 19.3	165.6 ± 49.7	NS	8	NS
	September 2001	215.0 ± 31.1	118.9 ± 53.2	NS	10	NS
Smoky River Drainage						
Smoky River (EXP)	October 2000	295.8 ± 81.1	368.6 ± 347.2	6.8 ± 5.1	12	7:4:1

REF Reference site
EXP Exposure site

[a] Ratio of males:females:immature
NS Not sampled

Table 18. Invertebrate composition and abundance in Arctic grayling diet, September 2000.

Waterbody	Mean Number of Aquatic Invertebrates	% of Total Invertebrates	Mean Number of Terrestrial Invertebrates	% of Total Invertebrates	Dominant Aquatic Taxa	% of Total Aquatic Taxa	Dominant Terrestrial Taxa	% of Total Terrestrial Taxa
Smoky River (EXP)	27.0 ± 27.2	5.0	510.4 ± 182.7	95.0	Ephemeroptera	42.2	Bibionidae	80.9
					Orthocladiinae	41.5	Formicidae	8.5
					Corixidae	6.0	Hymenoptera	4.7
							Perlodidae	1.8

Table 19. Mean volume (%) of food items in Arctic grayling stomachs, September 2000.

Waterbody	Terrestrial Invertebrates	Unidentified Fish/Mammals	Aquatic Invertebrates	Organic Detritus	Inorganic Material	Unidentified Detritus
Smoky River (EXP)	93.6 ± 2.3	0	3.4 ± 2.6	3.0 ± 2.2	0	0

Table 20. Mean dry weight (mg) and % composition of food items in Arctic grayling stomachs, September 2000.

Waterbody	Terrestrial & Aquatic Invertebrates		Unidentified Fish		Organic Detritus		Inorganic Material		Unidentified Detritus	
	Weight	%	Weight	%	Weight	%	Weight	%	Weight	%
Smoky River (EXP)	863.86 ± 382.15	96.2	0	0	33.63 ± 19.60	3.8	0	0	0	0

Table 21. Mean length (mm), weight (g) and age (years) of Arctic grayling, September 2000.

Waterbody	Site	Length (mm)	Weight (g)	Age (yrs.)	N	Sex Ratio[a]
Smoky River	Exposure	270.2 ± 34.8	253.4 ± 92.1	3.0 ± 1.0	5	3:0:2

[a] Ratio of males:females:immature
NS Not sampled

Length, weight and age data for Arctic grayling captured in the Smoky River are shown on Table 21. There were insufficient sample sizes for each sex to determine if there were differences between sexes. Fish ranged in age from 2 to 4 years with an average age of 3.0 years.

4.0 Summary and Conclusions

Not surprisingly, aquatic and terrestrial invertebrates were the dominant food items by both volume and weight in the diets of fish taken from reference and exposure area streams within the McLeod and Smoky River drainages. Fish formed only a small portion of the diet and occurred infrequently in the diet of only a small number of fish of all test species from a few streams. Aquatic invertebrates generally formed a larger part of the fish diet than terrestrial invertebrates by number, volume and weight except for Arctic grayling. In terms of preferred or selected food items, the number of different invertebrate taxa consumed by individual fish species was quite variable among months and among study sites and fish species.

Exposed vs. Reference Fish Comparisons

Based on invertebrate composition in fish stomachs, there was no clear trend evident in food preferences by the fish species sampled when comparing pooled reference streams to exposure streams. The invertebrates in the fish diet varied greatly both among study sites and within a study site over time. This suggests that the fish species under consideration were feeding opportunistically rather than selectively. However, it is also possible that they were feeding on the most available prey items. As stated in Section 1.3, no data for *in situ* invertebrate sampling was available to support this hypothesis.

In general terms mayflies (primarily Baetidae and Ephemerellidae) and chironomids (Orthocladiinae and Diamesinae) were the most common aquatic invertebrates consumed by most species of fish. Simulids, stonefly larvae and caddisfly larvae infrequently dominated the diet of fish. A diverse array of terrestrial invertebrate taxa was consumed by fish with march flies (Bibionidae), mayflies (Ephemeroptera and Baetidae), flies (Muscomorpha), and dance flies (Empididae) generally the most dominant food items.

A comparison of individual diet components for each fish species indicated that rainbow trout, bull trout, and mountain whitefish from reference and exposure sites (i.e., sampling sites pooled) in the McLeod River drainage fed on a similar volume and weight of terrestrial invertebrates, aquatic invertebrates, fish, organic detritus, and inorganic material. Therefore, although fish were feeding on a wide variety of invertebrates, the volume and weight of invertebrates ingested did not differ within a species and between exposed and reference fish.

For brook trout, a comparison of diet components between reference and exposure sites in the McLeod River drainage indicated that reference fish had a higher volume of terrestrial invertebrates than exposed fish. Conversely, exposed brook trout had a higher volume of aquatic invertebrates than reference fish.

Rainbow trout and bull trout from exposure sites in the Smoky River drainage fed more exclusively on terrestrial invertebrates than fish from the reference sites. Both the volume and weight of terrestrial invertebrates consumed by rainbow and bull trout was much higher in exposed fish. Small sample sizes or the absence of fish at reference sites did not allow for any comparisons of brook trout and mountain whitefish diet in the Smoky River drainage.

Monthly Within-stream Comparisons

Monthly sampling was done at a few reference and exposure sampling sites within the McLeod River drainage. No within-stream differences in the volume of diet components of rainbow trout were observed for Deerlick Creek and the Gregg River among the months that were sampled. However, in Luscar Creek, the mean volume of terrestrial and aquatic invertebrates was lower in September 2001 compared to the other months sampled. Conversely, the mean volume of aquatic invertebrates in the upper McLeod River was higher in September than in other months sampled.

No monthly differences in the volume of terrestrial and aquatic invertebrates in mountain whitefish and bull trout diet were found in the three streams (Upper McLeod River, Luscar Creek and Gregg River) where monthly sampling was done

Differences in the volume of terrestrial and aquatic invertebrates in brook trout diet were found in the four streams (Cold Creek, Upper McLeod River, Luscar Creek, Gregg River) where monthly sampling was done. There was a tendency for the volume of invertebrates consumed by brook trout to be less during September/October sampling events than during July and August.

No monthly within-stream comparisons could be made of diet components of fish from sampling sites in the Smoky River drainage since no seasonal sampling was done.

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6.0 Stantec Quality Management Program

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